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INTRODUCTION.

When, after serving five years, from 1868 to 1871, as Secretary of the Treasury in Mexico under President Juarez's administration, I was obliged to resign, my health being so greatly broken down as to make it impossible for me to continue discharging the duties of that responsible, and at the time, very difficult office, feeling that if I remained in the City of Mexico, I could not regain my health as I would be subject to continual mental excitement, I made up my mind to live in the country and occupy my time in agricultural pursuits. Before deciding what branch of agriculture I should follow, I made a tour of inspection to the most favored regions of Mexico and found that india-rubber and coffee raising seemed to be the most promising and profitable undertakings. The place which I thought best adapted to both of these products was the district of Soconusco, one of the counties of the State of Chiapas, in southeastern Mexico, bordering on Guatemala, and I concluded to settle there and apply myself to coffee and india-rubber culture.

My public duties for the last eighteen years have not allowed me much time to make new studies on coffee culture, but the interest I take in coffee raising has made me read all that came in my way on the subject; and I also made in 1896 special visits to the new coffee districts in the State of Oaxaca, Mexico, to study their conditions. I am very sorry that I have not the time indispensable to revise this edition, and have to publish it as it came out in Spanish, several years ago.

My sudden departure from Soconusco made me abandon and lose everything I had there. I, therefore, did not see grown the trees I had planted, but they grew well and yielded a large amount of fruit, of which a relative of mine availed himself, who made out of that plantation a large fortune, and finally bought from me the land occupied by the plantation at about the price of land there when the purchase was made.

In the several trips of inspection which I made in Mexico, I was careful to study coffee culture in every district I visited, and I published in the newspapers the result of my studies in the shape of articles relating to each district. They were finally reprinted in a book on the State of Oaxaca, which I published in Barcelona in 1886. It would take a great deal of space to publish them here, and they do not contain, so far as rules for coffee culture are concerned, any more information than appears in my manual on the subject.

GEOGRAPHY

LOCATION, BOUNDARIES, AND AREA.

Location.—Mexico is situated between 14° 30′ 42″ and 32° 42′ north latitude, and between 86° 46′ 8″ and 117° 7′ 31″ 89 longitude west of the meridian of Greenwich, embracing therefore 18° 11′ 18″ of latitude and 30° 21′ 23″ 89 of longitude. It has an area of 767,326 square miles. It is bounded on the north by the United States of America, on the southeast by Guatemala and Belize, on the south and west by the Pacific Ocean, and on the north and east by the Gulf of Mexico and the Carribean Sea.

Boundary with the United States.—The boundary with the United States is fixed by the treaties of February 2, 1848, and December 30, 1853, and begins at the mouth of the Rio Grande River on the Gulf of Mexico, follows the river for 1136 miles, to the point where it strikes parallel 31° 47′ north latitude, beyond El Paso, Texas, and from there runs along said parallel for a distance of one hundred miles, and thence south to parallel 31° 20′ north latitude; from there west along this parallel as far as the 111th meridian of longitude west of Greenwich; thence in a straight line to a point on the Colorado River, twenty English miles below the junction of the Gila; thence up the middle of the said River Colorado to the intersection with the old line between Upper and Lower California, and thence to a point on the Pacific Ocean, distant one marine league due south of the southernmost point of the Bay of San Diego on the Pacific; the total distance from El Paso to the Pacific being 674 miles. The whole extent of the boundry line between the two countries is 1833 miles.

The boundary line with the United States runs from southeast to northwest, the mouth of the Rio Grande being in 25° 57′ 14″ 74‴ north latitude; while the line reaches on the Pacific latitude 32° 32′ 1″ 34‴; the point where the boundary line strikes the Colorado River is farther north, reaching 32° 42′ of north latitude. Mexico has, therefore, on the western, or Pacific side, 6° 34′ 46″ 20‴ of latitude more than on the eastern or the Gulf of Mexico side.

General Characteristics.—Mexico is bounded on the east by the long curve of the Gulf of Mexico and by the Caribbean Sea, and its eastern coast is 1727 miles long; on the west it is washed by the Pacific Ocean, its coast describing the arc of a still larger circle, for a length of 4574 miles; but after passing the latitude of the City of Mexico, about the meridian 19° of north latitude, going south, the continent makes a decided turn towards the east, the Gulf of Mexico forming the northern border, and the Pacific Ocean the southern border.

Mexico has the shape of a cornucopia, with its narrowest end tapering toward the southwest, its convex and concave sides facing the Pacific and the Atlantic, respectively, and its widest end toward the north, or the United States. I look forward to the time, which I do not think far distant, considering our continuity of territory to the United States and our immense elements of wealth, when we shall be able to provide the United States with most of the tropical products, such as sugar, coffee, tobacco, india-rubber, etc.,[1] which they now import from several other countries.

The widest portion of Mexico is, therefore, its northern extremity, or its boundary with the United States. The narrowest point is the Isthmus of Tehuantepec, about one hundred miles from one ocean to the other; and after passing it the country expands again to the southeast towards Yucatan and Chiapas until it reaches the boundary with Guatemala and Belize.

The Mexican Southern Railway, from Puebla to Oaxaca, descends in a few hours, by a series of fertile terraces, from an elevation of seven thousand feet to one of about seventeen hundred and fifty feet, when ths wonderful Cañon de los Cues is reached, a region of cocoa-nuts and bananas. But all the valleys and terraces in March are green or yellow with wheat and corn and sugar-cane. It confuses one's ideas to pass a field of wheat, the green blades just springing from the ground, and then a field ripe for harvest, and then a threshing-floor where the grain is being trodden out by mules. This means that you can plant and reap every day in the year, if you can obtain water in the dry season, and do not wait for the regular and copious summer rains.

The magnificent arboreal vegetation embraces one hundred and fourteen different species of building timber and cabinet woods, including oaks, pines, firs, cedars, mahogany, and rosewood; twelve species of dyewoods; eight of gum trees: the cacao and india-rubber, copal, liquid-ambar, camphor, turpentine, pine, mezquite yielding a substance similar to gum-arabic, dragon trees, and the almacigo or *Callitris quadvalvis*, from which sandarac is extracted. Among the oil-bearing trees and plants, of which there are seventeen varieties, are the olive, cocoa palm, almond, sesame, flax, the tree yielding the balsam of Peru, and others. There are fifty-nine classified species of medicinal plants, and many more are mentioned by botanists as still unclassified by science.

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[1] In his *Notes on Mexico*, Lempriere, a distinguished traveller and historian, says: "The merciful hand of Providence has bestowed on the Mexicans a magnificent land, abounding in resources of all kinds—a land where none ought to be poor, and where misery ought to be unknown—a land whose products and riches of every kind are abundant and as varied as they are rich. It is a country endowed to profusion with every gift that man can desire or envy; all the metals from gold to lead; every sort of climate, from perpetual snow to tropical heat, and of inconceivable fertility."

Of the many delicious fruits which grow in the tropical regions, only a few—the pineapple, the banana, and the cocoa-nut—are known in this country, the orange being rather a semi-tropical fruit. The others require, as all fruits do, cultivated taste, and, therefore, if imported here would not find a market. Even those which do come here are of very inferior flavor, owing to the fact that they are cut green so as to prevent their decay during transportation, and they, of course, have a less agreeable taste than in the place where they grow. Of the banana, for instance, we have about twenty varieties, some of which—the richest in my opinion—grow to a size from twelve to fifteen inches in length and from two to three inches in diameter.

We can raise in Mexico all the products of the world because we have all climates, from the perpetual snow to the burning sun of the equator; but it would take a great deal more space than I can dispose of in this paper, to mention all the agricultural products we can raise, and I will, therefore, confine myself to only such as I think are now of more importance.

Coffee.—Mexico has many localities well suited for the raising of coffee, and the production of that berry can in the future be very largely increased. In the proper locality, namely, zone, ground, and climate, coffee can be raised on a large scale at comparatively small cost, affording always a large profit, whatever may be in the future its price in foreign markets.

It is interesting to know the production of coffee in Mexico, taken from some statistics for 1896:

Cordoba produces	10,000,000	lbs.
Huatusco and Coatepec	10,000,000	"
Oaxaca	6,000,000	"
Tabasco	5,000,000	"
Chiapas	3,000,000	"
Other districts	26,000,000	"
	60,000,000	lbs.

Sugar-Cane.—Mexico has many localities where sugar-cane can be raised at a very small cost, and where that industry can be made very lucrative, although we hardly produce enough sugar for our home consumption. From the sea-level to the frost line, which ranges, in different localities, from three to five thousand feet above the sea-level, sugar-cane can be raised in Mexico to great advantage. I have seen the cane in some places, especially in Soconusco, attain a height of twelve feet and a diameter of about five inches; and in some localities it lasts from ten to eighteen years without need of replanting, and can be cut for grinding twice a year. When it is considered that in some places, like Louisiana, sugar has to be planted, as I believe, every two years, and that it is liable to be destroyed by frosts, the advantages of Mexico for that industry are apparent.

The favorable conditions of Mexico for raising sugar-cane are so great that I have seen the natives in the Indian town of Loxicha, in the State of Oaxaca, plant a small plot of sugar-cane, grind it with primitive wooden mills moved by hand power, using very primitive earthen pans, to evaporate the juice and make brown sugar—losing of course a great part of the saccharine matter in the cane,—transport the sugar, sometimes a distance of thirty miles on mule-back, and sell it at one cent per pound, and still make a profit.

For sugar-cane the lowlands are the best, and the plant is essentially a tropical one. It will grow, however, at very considerable altitudes, but when planted in the mountains it takes a longer time to ripen, and soon ceases to give remunerative crops. There was in southern Veracruz a sugar-cane only six months old which had a circumference of 7½ inches. Where that cane grew the yield of cane per acre was about 80 tons when twelve months old. The elevation was something like 1000 feet. It is true, however, that the bulk of the cane grown in Mexico is to be found above 2000 feet, but I am convinced that a lower altitude would produce even better results.

Tobacco.—Among the tropical products of superior quality that we raise in the hot zone, I should mention tobacco, the Mexican tobacco being, in General Grant's estimation, superior to the Havana article. The natural conditions of soil and temperature are the same in Cuba and Mexico, but we had not the superior experience of the Cubans in curing the leaf until the late insurrection broke out in Cuba, in 1868, when a great many Cubans went to Mexico to plant tobacco. As the land has been planted in Cuba with tobacco for nearly four hundred years, and as tobacco is a very exhausting crop, it has become indispensable to manure the land with guano, while in Mexico we have virgin land, and tobacco being a comparatively new industry, no guano needs to be used. General Grant, whom I consider a competent judge, detected the taste of guano in the Havana cigars, of which ours is free, and he, therefore, preferred to smoke the Mexican cigars.

In Cuba the exhausted soil cannot produce all the leaves that are required for the world's supply of Havana cigars, and the want can only be filled through the use of Mexico leaf tobacco, the weed produced in other countries having similar conditions. The Marquis de Cabañas sent to Sumatra a quantity of seed when it became obvious that the soil of the tobacco region of Cuba was fast being worn out. He sent seed also to Java and to the United States, but it was found that it was impossible to raise tobacco of the quality of that raised in Havana anywhere but in Mexico. That raised in Java from Havana seed was very coarse and rank, replete with nicotine and meconic acid, and devoid of those delicate essential oils that give the Havana and Mexican tobacco their fine aroma.

The tobacco plant is a native of the tropics, and thrives best in the hot lands. It is a hardy plant, however, and will grow well in northern latitudes in the summer time. It often happens that the land in the tropics is actually too rich for the successful cultivation of tobacco.

India-Rubber.—The lowlands of Mexico, especially those adjoining the Pacific Ocean and which have a very warm and moist climate, are very well adapted for the india-rubber tree, which attains a large size and yields a considerable amount of india-rubber. We used to have whole forests of them, which fact shows that they were in their proper conditions of soil and climate, as they could outgrow the rank vegetation of the tropics, and prevent the growth of most of the other large trees in the forests; but india-rubber gatherers have destroyed most of them, and I imagine that there is a comparatively small number left.

I have always thought that the production of india-rubber would before long cease to be sufficient to supply the demand, and that, therefore, the value of that article would increase with the lapse of time. Now it is to be expected that the enormous expansion during the last few years of the cycle-tire, electrical motor-car, cab, and kindred industries will lead to the bestowal of increased attention on the world's rubber supply, which is so intimately associated with the existence of these industries.

Thinking that a plantation of india-rubber trees would be very remunerative, I devoted considerable attention to that subject, and in 1872 started one of 100,000 trees in a place admirably located for the purpose, bordering on the Pacific Ocean and between two large rivers, in the same district of Soconusco. In an article published in 1872, under the title "India-Rubber Culture in Mexico," I compiled all the information on the subject that I could obtain, supplementing it with the experience that I had acquired. Unfortunately, for reasons of a political nature, I had to abandon that plantation, and when the trees that I had planted grew large enough to yield rubber, they were tapped by the natives and entirely destroyed, but my work gave me an experience which I considered of great value. For further information on this subject I refer the reader to the above mentioned article.

The india-rubber trees that grow in Mexico are not the *Haevea guianensis* that grows in Brazil, but the *Castilloa elastica*, and if we have any of the *Haevea guianensis* I have not seen them.

Enough has been written lately on rubber cultivation to show that the profits, in Mexico at least, would be very great; indeed, 300 per cent. on the capital invested is a possible return, after five years, from cultivating *Castilloa elastica* in that Republic. This is a return which provides plenty of margin for contingencies. Rubber-growing is no longer in the experimental stage, as witness the plantation of La Esmeralda, in Oaxaca, to which further reference is made below. Cultivated india-rubber plantations are few, for the reason that, in some degree like the coffee plant, the india-rubber tree requires a long period of continuous cultivation before making any return to the cultivator. Mexico affords excellent opportunities for the development of this admittedly profitable industry. *On this point the authority of Sir Henry Nevil Dering, the British Minister to Mexico, who, in a recent report to the Foreign Office on the cultivation of india-rubber, says: "The regions most favorable for the growth of this important, yet rarely cultivated, india-rubber tree are the plains of Pochutla, Oaxaca, and also along the banks of the Copalita River where the tree is found in astonishing numbers. Few are the plantations of india-rubber trees existing in the Republic of Mexico. The principal one is La Esmeralda, in Juquila, Oaxaca, which has over 200,000 trees, eight years old." According to the same report the yield of 100,000 trees at the first year's harvest will bring the planter $120,000, besides the product obtained from the corn, vanilla beans, cacao, and bananas raised from side planting. The net profit on the investment, after deducting the entire cost of the land and all expenses up to the first year of harvesting, will be $95,000, and each of the succeeding harvests, for twenty-five or thirty years, will bring a steady income of over $100,000." This is 400 per cent. per annum net profit on the investment. These calculations are based upon the production of a five-year-old tree, but the report adds that "this product will be gradually increased every year for the next four or five years."*

Cocoa.—Cocoa is produced in several localities. That of Soconusco, in the State of Chiapas, is of so excellent a quality that when Mexico was a colony of Spain it was the only kind used by the Spanish royal family. On account of the expense and difficulty of transportation, and the cultivation of cheaper quality in other localities, the production has dwindled down to an insignificant amount, and now hardly enough is grown to supply the demand in that district; but it is universally acknowledged that the Soconusco cocoa is the best in the world.

The best elevation for cocoa is from 300 to 1000 feet, and the tree seldom thrives well at an altitude exceeding 3000 feet. Warmth and moisture are necessary for the successful cultivation of this plant.

The State of Tabasco produces a very good quality of cocoa, although it cannot be compared with that of Soconusco. In other places it grows very well also, but for various reasons the production, instead of being developed, has dwindled down until it is not enough for home consumption, and we have to import some, especially from Venezuela and Ecuador. One disadvantage of the cocoa industry is that the tree requires several years to reach maturity and to bear fruit, and few investors can afford to wait the necessary time.

Vanilla.—The vanilla bean grows very luxuriantly on the Gulf coast of Mexico, and it has been for some time a very profitable production, especially in the counties of Papamtla and Misantla, in the State of Veracruz, on account of the excellent quality of the bean and the high price which it brings. It grows in a region which is subject to intermittent and remittent fevers, and sometimes yellow fever, and where labor is very scarce; for these reasons it has not attained a greater development. I hardly think there is any locality where the vanilla vine grows better than in Mexico.

Vanilla requires a hot, moist climate, and, therefore, the lowlands are best suited for its culture. Very little of the vanilla produced in Mexico is at present grown at an elevation exceeding 1000 feet. At the same time it is claimed that in some places it thrives up to 3000 feet.

The vines will usually produce considerable vanilla in the third year, and they will yield considerably more during the fourth, fifth, sixth, and seventh years, and the production then begins to decrease. But before this time new rootlets have been dropped from the old plants, which form new vines that take the place of the old ones; thus the plantation is kept in a state of continued production. *The central portion of the Isthmus of Tehuantepec is one of the most suitable regions for its cultivation, as much wild vanilla is found growing in the forests there.*

The Mexican vanilla dealers have established five grades, namely: First, vanilla "fina," or legal, the beans and pods of six and a half inches long, or upwards, short in the neck, sound and black, and the beans which become split or open, provided they have the foregoing qualities and the split does not extend more than a third of the pod. This class is again divided into "terciada," which is composed of the shortest pods; "primera chica," "primera grande," "marca menor," and "marca mayor," the largest of all. Second, "vanilla chica," those pods which differ from the "terciada" only in being shorter, two of them counting as one of the first class. Third, vanilla "zacate," the pods of all sizes, which are off color through being gathered before becoming properly ripe, or being over-cured; "pescozuda," "vana," "cueruda," and "aposcoyonada," names for pods in a more or less damaged condition. Fourth, vanilla "cimarrona," the wild vanilla in good or fair condition, three pods counting as one of the first class. Fifth, the "rezacate," composed of the very short pods; of those split all the way up to the stalk, of the badly damaged, of the very immature, and of the greatly over-cured; of this, six pods count as one of the first class.

After the sizing and classification are finished, the pods are tied up in bunches of 100–150, so as to weigh one pound, and wrapped in filtering paper and tin foil.

Cochineal.—The cochineal is a bug which feeds on the cactus; and which, when fully developed, is brushed off the cactus leaves and roasted to prevent decomposition, being then ready for market. It is raised to great advantage in Mexico, and especially in the valleys of the State of Oaxaca. When it was the only article used to dye red it was very valuable, commanding sometimes between four and five dollars per pound, and it made the wealth of that State. But recent discoveries in chemistry have supplied other substances for dyeing which are very cheap, especially aniline, and the price of cochineal has fallen considerably, so that now it is hardly raised at all. When it had a high price, it was raised in Guatemala, and it was the beginning of the wealth of that State. It is now raised, I understand, in several other countries.

Yuca.—Yuca, or starch-plant, called manioc in South America, is a bush from four to six feet high, having tubers, like horse-radish, six to ten to every plant, and weighing from one to twelve pounds each. It is an important product of Chiapas and may be sown at any time, but it is better to do so from the stems when the rains begin, say in the month of May, by opening ditches five feet apart, and planting the cuttings, eight inches long, in them consecutively, leaving one foot between. Vegetable and sandy soil is best adapted for it, although it can be planted and will thrive in any kind of land. In arid and hard soil it needs plowing. If the land has been thoroughly cleared before planting it requires but little weeding during cultivation. A year after being sown, if the soil is rich, it will begin to yield tubers which must be dug up at the time the tree begins to flower. In replanting after digging the tubers, a slip is left standing and this will bear in twelve months. Besides extracting the starch from the tubers, the leaves are used as fodder for stock.

Sir Henry Dering, the British Minister to Mexico, sent recently to the Foreign Office some practical notes on the cultivation in Mexico of the "Yuca" or cassava plant, pineapple, ginger, "chicle" or chewing-gum, sarsaparilla, jalap, licorice, canaigre, and ramie, and I shall quote here from his notes on some of those products.

The yuca is to the peon, in the tropical section of the Republic, what potatoes are to the poor and working people of Ireland. Yuca is a native of the country, and its rise dates back before the conquest of Hernan Cortez, and it has always formed a portion of the food of the ancient and present Mexicans, especially those living in Veracruz, Oaxaca, Chiapas, Tabasco, and Yucatan. It has been estimated that the returns of yuca cultivation are immense; the yield of an acre contains more nutritive matter than six times the same area of wheat.

Ginger.—Ginger is found growing wild in various parts of Mexico. The returns from an acre of land vary considerably, but when cultivated under favorable conditions, the crops ought to be 4000 pounds and upward. A ten-acre patch would yield annually from $5000 to $7000.

Cabinet and Dye Woods.—In the low, hot countries we have all the cabinet woods growing wild and a great many dye woods, some of which are indigenous to Mexico, like the Campechy wood, not being found in other countries. It would take too long to enumerate the different kinds of cabinet woods we have, and I will only say that it happens with them as with our fruits, that only such of them as have been introduced here, like mahogany, cedar, rosewood, ebony, and a few others, are known in this country and in Europe, while hundreds of other kinds as hard as those and of as fine, if not a finer grain, are found in the wild woods of Mexico.

FRUITS.

We produce in Mexico a great many tropical fruits that are not sent to the United States because there is no market for them for the reason that they are not known here. Some of them are delicious, and with the facilities of communication, I have no doubt that they will become known and a taste will be developed for them in this country. I will speak here only of such of our tropical fruits as come to the United States.

The advantage of tropical fruits growing in their proper zone and climate is immense, as the expense of planting and cultivating them outside of their proper limits is very great and there is always danger of their destruction.

Oranges.—Orange trees, like any other fruit trees, depend in Mexico on the rain, and, except in a private garden or private grounds, are not irrigated. While the orange tree is a hardy plant, it thrives best and yields the most luscious fruit in the tropics. Elevation exceeding 2500 feet is not, as a rule, desirable for orange culture.

In flavor and productiveness the Mexican orange is unsurpassed. In the majority of the districts but little care or attention is given to the cultivation of the trees. Scientific orange culture in Mexico is practically unknown. The introduction from other countries of different varieties of the plant for experimental purposes is just being commenced.

The price of oranges in Mexico at the present time, in districts reasonably near lines of transportation, is about $11 per thousand, Mexican money, on the tree. It is the practice of the producer to sell the fruit on the trees, the buyer picking, packing, and shipping it at his own expense.

About one hundred trees are usually set out to the acre, the average yield being from 800 to 1000 oranges to the tree. I know of trees in Mexico which have a record of having produced 10,000 oranges. This, however, is very exceptional.

A properly cultivated and prudently managed grove at the end of five years' growth should prove as profitably as a coffee plantation of the same size, at the end of five years.

The production of the orange trees begins in the third or fourth year and increases up to the twelfth, and, in some cases, to the fifteenth or sixteenth year. It is considered best to cut the fruit up to the fifth year, not permitting it to mature.

A book prepared by Frederico Atristain, entitled *Cultivo y explotacion de Naranja*, and published by the Department of Fomento of the Mexican Government, contains a great deal of reliable information on the subject of orange culture in Mexico.

After an orange tree has been yielding sweet oranges for many years, it very likely exhausts the substances of the earth which give the sweet taste to the fruit, and it begins to lose its sweetness, until finally, if the land is not manured, as is almost always the case in Mexico, the oranges become bitter.

A recent cyclone, which lowered considerably the temperature in Florida, destroyed in one day, I understand, about 12,000,000 orange trees, thus causing ruin or serious loss to thousands of men engaged in that large industry, while the orange region in Mexico is entirely free from frosts and consequently from such dangers.

Lemons.—In the hot and temperate regions of Mexico lemons grow very well. There are some districts of the country, like Soconusco, where the natives plant the lemon trees very close together, for the purpose of making a hedge or fence, and, notwithstanding that the trees have not the necessary conditions of sunlight and air for their proper development, they grow very well. I do not know of any place in Mexico where lemons have been cultivated for commercial purposes; but I am sure they could be made a very lucrative industry.

Limes and Shaddocks.—Lime trees prosper very well in Mexico, bearing large amounts of delicious fruit. I have not seen in the United States any of our limes, at least such as are imported here are not like ours, and I have no doubt that if known our limes would find a good market in this country. The lime should not be planted at an altitude exceeding 1000 feet. We grow also a very large kind of shaddock, which we call "toronja," and which is not imported in this country, but which if known here would find a good demand. It grows very luxuriantly and attains at times a very large size, even eight inches in diameter, having a very thick peel.

Bananas.—The banana thrives anywhere from the sea-level to an elevation of 5000 feet, and is one of the many Mexican fruits which yield to the planter an immense profit. The whole Mexican coast produces the banana spontaneously and in very great abundance. On the lands near the sea, at an elevation of 600 to 700 feet, large plantations of bananas can be started at a cost of five cents per plant, including all expenses. At the end of the first year, the plants begin to bear, and 1000 plants, which have cost $50, will produce $1000 as a minimum. The following year the yield is double that amount, and almost without expense. At the end of one year, the plant produces one bunch which is worth in the United States from 75 cents to $1 gold, the cost to the farmer being not more than 25 cents per bunch in Mexican currency. After the first year, the sprouts from the old plant grow up and give double the first year's yield.

There is perhaps no tropical plant easier of cultivation than the banana. The suckers having been planted out at the commencement of the rainy season, they will grow vigorously, and produce fruit in about a year. The land must be kept free from weeds, and an occasional turning up of the soil will prove beneficial. Before the plant throws out its flowering stem, suckers will make their appearance above the ground, and these will require careful attention. While the plant is young, all the suckers except one should be cut away, the best plan being to sever them with a sharp spade. Thus all the vigor of the plant is thrown into the fruiting of the first stem, and the growth of the one to supplant it, and, in this way, fine large bunches can be reckoned on. The second stem usually produces a finer bunch of fruit than the first, but, as the land becomes exhausted, the bunches of course decrease in size, and this shows the necessity for manure in some form or other.

Bananas are used extensively as shade for young coffee and cocoa trees, and in places where an export banana trade has been established, the formation of a cocoa plantation is a very inexpensive matter, as the return in fruit from the bananas will pay for the cultivation of the cocoa until the trees are able to give a small crop.

The important feature, and the one upon which the success and profit of the industry depend largely, is that of cheap and certain transportation facilities. That requisite is easily obtainable; for instance, there are extensive and cheap lands for sale along the Tampico branch of the Mexican Central Railroad, from which the fruit can be shipped either all by rail, or by rail to Tampico, and thence by boat.

We have many kinds of bananas in Mexico, of different sizes, colors, and flavors, ranging in length from two to eighteen inches, and from one-half of an inch to three inches in diameter. The largest, which in some places are thought unfit for food, are in others, like Soconusco, considered the best; very likely on account of their different quality. When roasted the latter are very juicy, and taste exactly as if they had been preserved in sugar. Some people on the coast live almost entirely on bananas, this fruit forming their principal food. The banana is likewise a tropical plant, and thrives best on the lowlands.

Pineapple.—The Toltecs and Aztecs knew how to cultivate the pineapple, and when the Spaniards conquered Mexico, they found the fruit in the markets of the towns on their way from Veracruz to the great Tenochtitlan. "From time immemorial," Sir Henry Dering says, "the pineapple has been cultivated in Amatlan, a town five miles south of Cordoba, from where the ancient Mexicans used to get their main supply." Now it is grown in tropical Hidalgo, Puebla, Veracruz, Tabasco, Chiapas, Oaxaca, Morelos, Guerrero, Michoacan, Colima, Jalisco, and Tepic. "Besides the fruit being very delicious and wholesome," Sir Henry Dering says, "a fine wine and vinegar are made of the juice. The leaf furnishes a fibre of extraordinary strength and fineness, making it even more valuable than the fruit. The fibre is made into ropes, cables, binding twine, thread, mats, bagging, hammocks, and paper. A pineapple rope three and a half inches thick can support nearly three tons. A textile fabric as fine and beautiful as silk is made of this fibre too. It is believed that the fine cloth of various colors used by the upper classes among the Aztecs was made of the pineapple fibre. The modern Mexicans do not manufacture it much now, except in the Isthmus, where the Zapotec Indians still make a cloth from it and from wild silk. One cause for its disuse is the slow and wasteful manner in which it is separated." Pineapples will grow at elevations of from 2000 to 3000 feet above the level of the sea, but the best and most delicate fruit is produced on the lowlands.

Cocoa-Nut.—We have in our lowlands near the sea many kinds of palms called corozo, bearing different kinds of fruit, growing in large bunches and the fruit very abundant, being in the shape of a small egg, very rich in oils, and making also a very good food, although it is hardly used now for any purpose. The palm tree bearing the cocoa-nut grows, of course, very luxuriantly, and does not require any care after it is once planted. The cocoa-nut prefers the sea-coast and high temperature. The saline breezes from the sea are very beneficial to it. I have not seen in Mexico the species of palm bearing the date, perhaps because it has not been planted there; but I am sure that we could raise it, as we have several sections with a climate similar to that of Egypt and Asia Minor, where the date palm grows so well.

RAILWAYS.

The Veracruz road was finished in 1873, during Señor Lerdo de Tejada's Presidency, and when General Diaz became President in 1876 he earnestly promoted railroad building; and we now have two trunk lines connecting the City of Mexico with the United States—the Mexican Central to El Paso, Texas, with a branch from San Luis Potosi to the port of Tampico, and another from Irapuato to Guadalajara, which has recently been extended to Ameca, towards the Pacific; and the Mexican National to Laredo, Texas, with several branches. Another trunk line from Eagle Pass to Torreon and Durango, which it is intended shall finally reach the Pacific, has also been built by Mr. C. P. Huntington and his associates. There is besides a line from Nogales to Guaymas, built and owned by the Atchison, Topeka, and Santa Fé Company; and these four lines connect us with the main systems of the United States, our lines being in fact extensions of the United States railway system.

We have now two lines from the City of Mexico to Veracruz, the old Veracruz road passing by Orizaba, and the Interoceanic, which runs from Veracruz by Jalapa and the City of Mexico and is intended to reach the Pacific. All of our roads, excepting the one built by Mr. Huntington, have had large subsidies paid by the Mexican Government, and in one case, that of the Veracruz railroad, the subsidy paid was $560,000 per year, for twenty-eight years, or about $57,471 per English mile, although the average subsidy per mile, according to President Diaz's report, dated November 30, 1896, is $14,380.

The Tehuantepec railway, running from Coatzacoalcos on the Gulf of Mexico to Salina Cruz on the Pacific, about one hundred and thirty miles in length, has been built at great expense and at a great sacrifice by the Mexican Government. I published in the *Engineering Magazine* for March, 1894, an article stating the different efforts made by the Mexican Government to have that road built, and the advantages that we expected from it as a highway of trade between the Atlantic and the Pacific. *The Mexican Government has recently made a contract with Messrs. E. Weetman, Pearson & Son, of London, for the building of good harbors at both ends of the road, and when that is accomplished we expect that a great deal of eastern trade will pass through Tehuantepec.*

With the exception of the Tehuantepec road, we have not yet any road running from the Atlantic to the Pacific, although several are in process of construction. The descent of the mountains is on the Pacific slope a great deal more difficult than on the Gulf coast, where the large centres of population are located near the Gulf, and this explains why none of the roads have so far been able to reach the Pacific Ocean.

Our railway system extends now, in the direction of Guatemala, as far as the city of Oaxaca, where we are only about five hundred miles away from our frontier with Guatemala. In other directions, our system reaches the principal cities and commercial and mining centres of the country.

The total mileage of railway in 1895 was 6989½ English miles. President Diaz, in his above mentioned report gives, the total mileage of railways in Mexico as 11,469 kilometres or 7126 miles; and in his message to Congress on April 1, 1897, he stated that the railway mileage had been increased by 238 kilometres 550 metres, finished and received by the Government, and 248 kilometres built, but not yet received officially, making a total mileage of 11,955 kilometres 550 metres, or 7.429 miles.

President Diaz's Railway Policy.—President Diaz deserves a great deal of credit for his efforts to promote in Mexico, material improvements, and especially in railroad building. When he came into power, in 1877, public opinion was very much divided as to the policy of allowing citizens of the United States to develop the resources of the country by building railroads, working mines, etc. Our experience of what took place in consequence of the liberal grants given by Mexico to Texan colonists made many fear that a repetition of that liberal policy might endanger the future of the country by giving a foothold in it to citizens of the United States who might afterward, if circumstances favored them, attempt to repeat the case of Texas. President Lerdo de Tejada seemed to share such fears judging by his policy in this regard. But President Diaz, as a broad-minded and patriotic statesman, believed that the best interest of the country required its material development, and that it would not be advisible to discriminate against citizens of the United States, as that country was more interested than any other, on account of its contiguity to Mexico, in developing the resources of our country by building an extensive system of railways, and would, therefore, be more ready than any other to assist in building them. He trusted, at the same time, that when the resources of the country should be more fully developed, it would become so strong as to be beyond reach of the temptation by foreign states or individuals. The results of the work done in Mexico so far show that General Diaz acted wisely, and proved himself equal to the task before him.

IMMIGRATION.

The principle obstacle which has prevented us from having a large immigration is our low wages. Those who immigrate are generally poor wage earners, who want to better their condition, and they could not go to a country where wages are a great deal lower than in the United States, or even in Europe, as they could never compete with the native labor of our Indians. We have now a surplus of labor and a deficit of capital, and cannot have a large immigration until such conditions are changed.

What Mexico needs is capital to develop her resources and give employment to labor, and then immigration will flow in as naturally as water seeks its level. Mexican credit will be established, so far as immigration is concerned, when her natural resources are developed, this being the only safe and reliable basis of such credit, and this will never be developed until those who have capital to invest are acquainted with the unparalleled opportunities for safe and profitable investment in Mexico. This will only be accomplished by plain, blunt, matter-of-fact and well-informed press agents, who lay before people who have money to invest the plain facts of the case.

Immigration from the United States.—I have often been asked for my opinion of the chances of Americans going to settle in Mexico, and have always answered that while Mexico is desirous of attracting good settlers, and while that country undoubtedly offers great inducements to foreign settlers, especially to those having some means, there are serious drawbacks which ought to be pointed out to the prospective immigrant from the United States, as a warning against a possible failure and disappointment.

For the American common laborer who looks to his day's pay for his living, Mexico is unquestionably not the proper place to go. He cannot compete with the Mexican laborer, whose usual pay is from 38 to 50 cents a day in silver, and he boards himself. For the man who has no means, unless he is especially qualified in some particular branch, and knows something of the language, and will work harder and longer hours, it is no place. There is room for the steady, sober, industrious mechanic or miner or tradesman who will adapt himself to new conditions and surroundings, leave all social, political, and other ambitions behind him, and who will attend strictly to his own business.

Those who are safest in going to Mexico are those who have a little capital, say from $2000 in gold and upward, which will give them about twice that amount there; who can look around and decide what they propose to do, and where they want to settle. There is an excellent field for the small general farmer of the New England or Middle

States type, who will raise a little of everything. Butter, potatoes, hogs, poultry, corn, vegetables, and small grain find a ready sale at good prices. I have seen the common article of corn, which is nearly always a sure crop, sell at from $1 to $1.25 per bushel, Mexican money.

The climate of Mexico permits a man to work every day in the year. The cost of living and clothing is cheap, and a dollar in Mexican money can be made to go as far there as a dollar in American money in the United States, and a dollar there is easier to get.

COFFEE CULTURE.

I.

INTRODUCTION.

The desire of contributing, in however slight a degree, to the development of the cultivation of coffee in the State of Chiapas, which, when undertaken on a large scale, will become the chief source of wealth of a considerable part of its territory, induces me now to take up my pen for the purpose of setting down the results of my own observations and of those of several experienced planters of Guatemala, giving them the form of practical instructions, which may also be of use to the people of the other States of the Mexican Confederation who may be favorably situated for this industry and who may desire to avail themselves of the advantages which it offers. I will note down, then, what I consider to be the fundamental principles of coffee culture; and I think I may say with certainty that the rules here given will produce good results in a soil and climate similar to those of Chiapas, if they be faithfully and judiciously followed. To give these rules is the purpose of the present work.

It is also my purpose to show how easy the cultivation of coffee is, and how large are the profits it yields, in order to encourage my countrymen to devote themselves to so profitable an industry. Those whose pecuniary resources will not allow them to undertake it on a large scale may do so on a small one, certain of good results, and of being able, with the profits which a small plantation will yield to form a larger one in the course of a few years, which will assure their future.

In order to appreciate the advantages to be derived by the Chiapas coast from coffee cultivation, it will be sufficient to compare the Guatemala of twenty years ago with the Guatemala of to-day. Lands entirely uninhabited have suddenly become transformed into well-cultivated fields; towns and cities that had fallen into decay have sprung into prosperity as if by magic, and are steadily increasing in wealth; new roads to facilitate transportation are being constantly constructed; commercial transactions have greatly multiplied; the revenues are increasing; public credit is being re-established; and what, not long ago was a decadent, impoverished, and almost ruined country has become, thanks to the beneficent results of the cultivation of coffee, a rich and prosperous State. I see no reason why Chiapas, if it follows the same course, should not attain the same results.

The great agricultural progress made by Guatemala will be better understood if we consider how valuable land has become there. While the best land situated in the Valley of Mexico, in the vicinity of the capital, is estimated at an average value of $100,000 the square league, land situated in the vicinity of the city of Guatemala, for the reason that it is suitable for coffee, sells at $500 per lot of 10,000 square varas, at which rate the Mexican square league would be worth the fabulous sum of $1,250,000.

On the various occasions on which I have visited Guatemala I have made a special study of coffee culture, which is assuming such large proportions in the neighboring Republic. The greater number of the rules set down in this work, therefore, are based upon experience acquired in Guatemala, for, unfortunately, the cultivation of coffee in Soconusco has not yet attained the necessary proportions to base on it a body of rules. This will explain the frequent references which I shall make to Guatemala in the course of this work.

The best coffee-growing districts of Guatemala are those called there "Costa Grande" and "Costa Cuca," which are the prolongation of the chain of mountains which crosses the southern part of the State of Chiapas, and runs here, as in the neighboring Republic, very near the Pacific, and almost parallel with it. The land on that coast, therefore, is not inferior to the best in Guatemala; if there is any difference between them, it is that the Soconusco land is better watered.

I shall not give here the botanic classification of the coffee tree, a description of the plant, the chemical analysis of its fruit, nor an account of its discovery and use, for although all this is of undoubted interest, it would draw me aside from my main object, which is to lay down practical rules for the cultivation of coffee. I think it necessary, however, to say that science has done little hitherto, at least so far as I know, in favor of this industry. I have not been able to find any information regarding the chemical analysis of the soils suitable for the cultivation of coffee, nor of other scientific operations whose results would afford a sure basis for methods for its better cultivation. It is plain that if the component substances of the soil which nourishes the coffee tree and those which form its fruit were known with certainty, it might be determined with accuracy what kind of soil and what fertilizers are best adapted to it; and by using these not only might the plant be made to live longer but also to yield larger crops. Chemistry and geology have done much for certain plants; the cultivation of the cereals has attained to almost mathematical precision in Europe. Thanks to the advancement made in these sciences, the substances which each crop draws from the soil may now be determined with exactness, and, as a consequence, the substances which should be used as fertilizers, in order to supply the losses caused by the crops. When such data respecting coffee can be obtained, great advancement will have been made in its cultivation, which will not until then cease to be empirical.

II.

FUTURE OF COFFEE CULTURE IN MEXICO.

The use of coffee is becoming general everywhere. Whether it is that certain beverages at certain periods become fashionable, and that coffee is at the present time one of these, or that it really has properties which make it beneficial to the human constitution, certain it is that the sphere of its consumption is widening notably. Mexico is not exempt from this tendency; a few years ago coffee was hardly used in the Republic, while now it begins to compete with cocoa, and even with the national drink made of Indian corn.

Hardly five years ago coffee was sold in Soconusco at five dollars per quintal; low as this price was it yielded a profit, but did not make it worth while to extend its cultivation. Many still fear that the prices of the last two years were exceptional, that they will before long sink to their former level, and that coffee on the plantation will not sell for more than eight dollars per quintal. The crop of 1872 sold at from ten to twelve dollars per quintal on the plantation; and that of 1873 at eighteen dollars per quintal. Although it is true that this is an exceptional price, I think it probable that coffee will not fall lower than ten dollars on the plantation, which will still leave a good profit, as will be shown farther on.

Mexico is, besides, destined, from its proximity to the United States, to become the chief source of supply for that country, which is the country that consumes the largest quantity of coffee in proportion to the number of its inhabitants. Transportation will be easier when we are connected by rail with the United States, for the Central States of the Union would find it more to their advantage to import coffee from Mexico overland than by way of New York or San Francisco. That market would of itself suffice to consume all the crops that the country could raise for several years to come.

These considerations, which I touch upon briefly, lead me to believe that far from being attended by any risk, coffee-growing is, and will continue to be for some time to come, one of the most lucrative branches of agriculture to which the Mexican farmer could apply his labor and intelligence.

One of the principal drawbacks to coffee-raising is that a plantation does not begin to yield until from three to five years after planting, according as it has been planted from seeds or from the nursery, and few persons can afford to make the outlay required during that time without obtaining meanwhile any return from the money invested.

Soconusco offers in this respect, also, advantages which are hardly to be met with elsewhere. The soil best adapted for coffee is also that which is best adapted for sugar-cane. In the cold, high lands adjacent to this District, which do not produce sugar-cane, there is a considerable population of Guatemalan Indians who are obliged to buy there the sugar they require, whether for food or to make brandy, which is largely consumed in that Republic. For this reason, there is generally a great demand in Soconusco for sugar, which consequently brings a good price. The buyers come down for the sugar to the ranches in which it is made, so that it is not even necessary to carry it to market.

As the sugar-cane requires much less time to come to maturity than the coffee plant, and its cultivation, by reason of the high price which sugar brings here now, and is likely to continue to bring, yields good profit, it is not only possible, but easy to derive from it the funds necessary to start a coffee plantation.

Land Best Adapted for Coffee.—Experience shows that the coffee plant grows and thrives better in virgin soil than in soil that has been already cultivated. The reason of this is obvious. Virgin soil is richer, has its fertilizing elements almost intact, and produces fewer weeds. Because of this last advantage, virgin soil requires, during the years immediately following the planting of the coffee-trees, fewer clearings than that which has been already cultivated.

The only advantage of planting coffee in ground that has been already cultivated is that in that case the trifling expense of the felling is avoided.

III.

COFFEE CULTIVATION.

It is my purpose here to set forth with as much clearness and conciseness as may be possible the fundamental principles of modern coffee-culture, to the end that even those who have never seen a coffee-tree, may be able to undertake the raising of coffee with a good probability of success.

I will consider at greater length—because of the important bearing which they have on the success of the undertaking—the questions whether or not coffee-trees should be planted in the shade, and what distance apart they ought to be planted; discussing afterwards the other points directly connected with the cultivation of coffee and its preparation for the market.

I will make occasional references to the methods followed in the cultivation of coffee in Ceylon; for I have observed that there is a great similarity between them and the methods that have given the best results here. The excellence of Ceylon coffee is well known. In the year 1868, 913 plantations produced 1,007,214 English quintals of coffee. *Trees planted in the last century still yield good crops.* These facts show how far advanced coffee culture is there, and therefore the references that may be made to the system followed in Ceylon cannot but be useful to the Mexican planters.

I. DISTANCE BETWEEN THE PLANTS.

To proceed with greater method in the discussion of this important subject, the following points will now be considered:

A.—General considerations regarding distance.

B.—Number of plants in each cuerda according to the distance between them.

C.—Yield of each cuerda.

D.—Space required by each plant.

E.—Advantages of long distances.

F.—Advantages of short distances.

G.—Rules regarding distance.

Each of these points will be considered separately.

A. General Considerations regarding Distance.—There is a great difference of opinion among planters with regard to the distance apart at which the trees should be planted, some preferring long and others short distances between them. The practice most generally followed is to plant them three varas apart, from tree to tree and from furrow to furrow. Some time ago this distance began to be regarded as too short, and plantations were laid out with the trees three and a half, four, and even four and a half varas apart. Afterwards a reaction set in, and there is now a tendency to shorten these distances.

I think that the distance apart at which trees should be planted depends on the zone, altitude, temperature, and kind of land selected for the plantation. In a climate and soil favorable to their fullest development, the trees should be planted farther apart than when they are planted where the conditions are less propitious.

The question of distance is also intimately connected with that of the pruning of the trees, as by means of this operation the trees may be considerably reduced in bulk, and may therefore be planted even a shorter distance apart than in localities more favorable for coffee, as will be seen farther on. This question, however, will be better understood and a correct decision more probably reached after a consideration of the data to be given farther on.

B. Number of Plants in each Cuerda.—A cuerda of land, which is the unit of agrarian measurement in Soconusco, and which contains twenty-five yards square, or six hundred and twenty-five square[1] varas, will contain, in round numbers, thirty-nine trees, planted four varas apart on all sides; planted three varas apart, from plant to plant, and four yards from furrow to furrow, the cord will contain fifty-two trees; planted three and a half varas apart on one side and three varas on the other, the cuerda will contain fifty-nine trees; planted three yards apart on each side, it will contain sixty-nine trees; and one hundred and four if planted two varas apart from plant to plant and three from furrow to furrow. Planted in this way there will be a square, or a rectangular parallelogram, between each four plants.

In some plantations the system is followed, when the trees are planted farther apart than three varas on each side, of planting an additional tree in the centre of each of the squares or parallelograms formed by the plants.

The results of that manner of planting are the following: When the trees are planted four yards apart on each side, each cuerda will contain, planting a tree in the centre of each square, twenty-seven additional trees; that is to say, a total of sixty-six trees instead of thirty-nine. If the same thing is done when the trees are planted four yards apart on one side and three on the other, the cuerda will contain thirty-eight additional trees, or a total of ninety, instead of fifty-two. If the trees are planted three yards and a half from furrow to furrow and three yards from plant to plant, the cuerda will contain forty-six additional trees, which gives a total of one hundred and five trees. In squares of three yards on each side, fifty-three additional trees may be planted, making a total, with the sixty-nine already counted, of one hundred and twenty-two; and when the trees are planted three yards apart on one side and two on the other, a cuerda will contain eighty-three additional trees, which, added to the original one hundred and five, give a total of one hundred and eighty-eight.

C. Yield of each Cuerda.—Considering the average crop per year of each plant to be two pounds of coffee, each cuerda, when the plants are four yards apart on each side, will yield seventy-eight pounds a year; one hundred and four pounds if the plants are three yards apart on one side and four on the other; one hundred and thirty-eight, if they are three yards apart on each side; and two hundred and eight pounds if they are two yards on one side and three on the other.

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[1] Yard is used here for a Mexican vara.

When the additional tree is planted in the middle of each square, or parallelogram, the yield of each cuerda will be one hundred and thirty-two pounds, if the trees are planted four yards apart on each side; one hundred and eighty pounds if they are planted four yards apart on one side and three on the other; two hundred and ten pounds, when they are three and a half yards apart on one side and three on the other; two hundred and forty-four pounds, when they are planted three yards apart on each side; and three hundred and seventy-six pounds when they are planted two yards apart on one side and three on the other.

It must be observed, however, that the yield of each tree depends also on the nature of the soil, on the climate, on the degree of moisture, and the other circumstances which have been already enumerated, including the distance apart at which the trees are planted, for if they are planted too close together, so that their roots interlace, the yield will be less.

D. Area Required by each Tree.—If the trees are planted two yards apart, from plant to plant, and three yards from furrow to furrow, each tree will have an area of six yards square; if planted three yards apart, from plant to plant and from furrow to furrow, each plant will have an area of nine yards square; if planted three and a half yards apart on each side, of twelve and a quarter yards; and of sixteen yards square, if planted four yards apart on each side.

When an additional tree is planted in the middle of each square, or parallelogram, each plant will have an area of ground nearly eight yards square; if the trees are planted four yards apart on each side, of a little more than six; when planted three yards apart on one side and four on the other, of nearly five yards square; when planted three and a half yards apart on one side and three on the other; of four and a quarter yards square, when planted three yards apart on each side; and of nearly one and three quarter yards when planted three yards apart on one side and two on the other.

E. Advantages of Long Distances.—The advantages of long distances are the following:

1. Unimpaired growth of the plant. This advantage is nullified when pruning is performed, as will be seen when this subject is spoken of.
2. Freer circulation of air and light.
3. Greater yield of fruit of each tree.
4. Greater facility for cultivating the soil and gathering the fruit without injuring the branches of the neighboring trees.

When the trees are planted far apart and by this I mean at a greater distance than three and a half yards, their branches will not interlace, and free circulation of air, light and heat among the branches and trunks of the plants will be secured. When there is a free circulation of air, and the branches of the trees are exposed to the light and heat of the sun, it is evident that the yield of each tree will be greater than if it did not enjoy these advantages. Besides which, there will be more space between the trees for the laborers to perform their several tasks and the gatherers of the fruit to perform theirs, without injury to the branches of the neighboring trees.

F. Advantages of Short Distances.—The advantages of short distances are the following:

1. A greater number of trees will be contained in the same space of ground.
2. Consequent economy of hands and money in the labors of the plantation.
3. Greater yield of fruit in a given extent of ground.
4. Greater facility for gathering the crop; for, the trees being nearer together, it will be easier to strip them of their fruit.
5. Fewer weeds will grow, as a smaller area of ground will be exposed to the direct rays of the sun.

These advantages are so important as to make short distances preferable, as will be shown farther on.

G. Rules regarding Distance.—The preceding data regarding the number of trees contained in each cuerda and their product, demonstrate the expediency of planting the trees as near together as possible, in order not to waste space, provided that this proximity does not injure the productiveness of the plants.

It is to be observed that in recommending, as of great advantage, the planting of the trees short distances apart, the question is not simply one of economizing ground on account of its cost, which would be a very trifling advantage, indeed, where ground costs as little as it does in Chiapas—but of economizing labor, time, and money, things worth considering everywhere, and more especially in Soconusco, where there is a great scarcity of hands.

Now, then, as the chief expense of a plantation is in keeping it clean of weeds, and as this is done by task work, the weeding of a cuerda being a day's task for a man, and costing on an average two reals, it is evident that the cost of keeping a cuerda free from weeds is the same whether it contains thirty-nine trees or one hundred and four trees, and whether each cuerda yields seventy-eight pounds or two hundred and eight pounds of coffee. Each weeding, for instance, of a plantation of 10,000 trees, covering an area of two hundred and fifty-six cuerdas, will cost $64, if the trees are four yards apart on each side; while, if they are two yards on one side and three on the other, the same number of trees would occupy an area of ninety-six cuerdas, and cost $24.

Besides which, where there is a scarcity of hands, it would be easy to keep a plantation of some extent free from weeds if there were one hundred and four trees in every cuerda; but, to keep the same number of trees free from weeds, if there were thirty-nine in each cuerda, almost three times the number of hands would be required.

The system of pruning which has been tried with so much success in various plantations of Guatemala, and which, it may be said, has been carried to perfection in Ceylon, has the advantage of diminishing the foliage and increasing the fruit, and of preventing the branches of the coffee-trees from interlacing. This system consequently allows of closer planting, without the objections above indicated.

Taking all these considerations into account, I am of opinion that, other circumstances permitting, the best system is to plant the trees at a distance apart not exceeding three yards between the furrows and two between the trees. An area of six yards square ought to be sufficient for each plant.

Planting an additional tree in the centre of every four trees, forming a quincunx, has the objection that the advantage of the straight furrows is thereby lost, and that the intermediate trees present an obstacle to the free circulation of the air. I think that this system should only be adopted in the case when, a plantation being already laid out at long distances, it is desired to shorten these.

The distance apart at which trees are usually planted in Ceylon is six English feet, or a little more than two yards on each side. Considering the size to which trees are allowed to grow there—which will be indicated when speaking of pruning—this distance does not seem unduly short. Mr. Sabonadière is of opinion, however, that it would be better to plant them at a distance of seven feet from furrow to furrow and six from tree to tree.

2. NURSERY.

The nursery is the bed where, for greater convenience in attending to them, owing to the limited space which they occupy, the young plants are grown, until they are of sufficient size to transplant to the plantation.

The nursery may be formed of seeds, young plants, or slips, as will be seen farther on.

The following points in relation to the nursery will now be considered:

A.—Advantages of a nursery.

B.—Land suitable for a nursery, and its location.
C.—Seed-plot.
D.—Nursery formed from seeds.
E.—Nursery formed from young plants.
F.—Nursery formed from slips.
G.—Nursery of plants that are for sale.
H.—Nursery in Ceylon.

Each of these points relating to the nursery will be considered separately.

A. Advantages of a Nursery.—It is advisable that the plants with which it is intended to stock the plantation should be grown in a nursery. The seed might, it is true, be at once sown in the plantation; but its cultivation would in this case be much more costly, and a considerable number of plants could not be so well cared for as when they are planted close together in a small space of ground.

A nursery of a cuerda will conveniently contain 4000 plants, set at a distance apart to be indicated below, and the weeding of the cuerda would cost fifty cents, supposing a man to employ two days in the work; or, at the most, a dollar, if four days be spent on it; while 4000 plants in a plantation, at a distance of three yards from furrow to furrow and two from plant to plant, would occupy at least thirty-eight cuerdas; and, fixing the weeding of each cuerda at twenty-five cents, the weeding of the 4000 plants would cost $9.50. As the weeding must be frequently repeated, especially while the plant is very young, the economy of the nursery system will be easily understood.

A nursery is, besides, indispensable to a plantation, not only to form it but also to maintain it, as plants which wither or die have constantly to be replaced, and a good supply of healthy plants must be kept on hand for this purpose.

B. Land Suitable for a Nursery and its Location.—To form the nursery, virgin soil should be selected. If there is level ground, this should be preferred. If undulating, ground should be chosen sloping from north to south, with lofty trees to the east, to shade the nursery from the heat of the sun in the early morning hours.

The ground is prepared beginning with what is here called stubbing; this consists in cutting down the young trees, bushes, and other vegetation which can be cut with the machete; the large trees are then felled. To dispose of the leaves, branches, and trunks which remain after these operations, it is customary to allow them to dry and then burn them.

In land intended for coffee it is not advisable to burn this waste matter; especially should burning be avoided on land intended for the nursery.

All the branches, twigs, and leaves left by the operation of stubbing and hewing should be gathered in heaps and placed above and below the nursery, at distances of from twenty-five to thirty yards apart. Trunks of trees which are very large are to be left where they have fallen, as it would take much time and labor to remove them. All the trunks and shoots that might sprout are to be destroyed by the machete and the axe, without using the spade. These operations being performed, the ground is ready for the sowing of the nursery.

Some planters dig up the ground for the nursery, with the object of making it more fertile, and, as will be seen farther on, this is done in Ceylon; but it seems to me that, while this system may be a good one in poor soil, it is not so good in the soil of this coast, as the nursery will thrive here without this requisite; and as, besides, if the ground were dug up, weeds would grow more luxuriantly, and the rains would soon wash away the richest part of the soil.

Nurseries are to be formed at various points on the land where the plantation is to be laid out, for convenience in transplanting the young trees. The seed-plot is to be placed beside the nursery.

C. Seed-Plot.—The seed-plot is a sort of nursery for the nursery. To form the seed-plot, the berries or seeds of the coffee, are planted, six inches apart, in holes half an inch deep, and lightly covered with earth. All the rules for choosing the land and for sowing the seed nursery, to be indicated farther on, are also to be observed in the care of the seed-plot.

When the seeds have germinated, and the young plants are sufficiently grown to bear transplanting, they are to be transferred to the nursery, where they are to be planted farther apart, and where they are to be kept until they have attained sufficient growth to be transplanted to the plantation.

For my own part, I consider the system of combining the seed-plot and the nursery preferable, as labor, time, and money are thus saved, and a transplantation, from which the young plant always suffers, is, besides, avoided. This is the system followed in Ceylon, as will be seen farther on, and this seems to me another proof of its superiority.

D. Nursery from Seeds.—It is preferable to form the nursery from seed. In regard to this subject the general rules for forming nurseries from young plants or slips will be given.

To take up the points in their order, the following will now be considered here:

a.—Preparation of the ground for the nursery.
b.—Time for planting.
c.—Seed.
d.—Planting.
e.—Replanting.

f.—Cultivation.

g.—Pruning.

h.—Time for transplanting.

Each of these points will be considered separately.

a. Preparation of the Ground for the Nursery.—The nursery must be laid out in ridges. Each ridge should be a yard and a quarter wide and as long as the ground will permit, if this is hilly, or as may be desired, if level. The ridges, in hilly ground and on slopes which run from north to south, should run from east to west. Between the ridges a space of a third of a yard must be left to serve as a path, and at the same time as a trench for draining the ridges.

The paths should be six inches deep; the earth, dug from the paths to give them this depth, is to be thrown on to the ridge lying to the north. All the paths are to be drained by means of a deep trench made on the east or the west of the land, according as this will allow, and which is to run from north to south, so that the rains may never flood the ridges. Care must be taken to keep the paths, as well as the ditches, open.

b. Time for Planting.—The rains must determine the time for planting the nursery. If planted from seed, the operation may take place a month before the rainy season begins, as the seed takes about six weeks to germinate, and when it appears above the ground the rainy season will have already set in The rainy season generally begins in April, in Soconusco; consequently the planting of the nursery may be done in March.

The seed should be sown on a cloudy day, and it will be better still to sow it when it is raining.

c. Seeds.—The seed of the coffee-tree proceeds from the fruit, which somewhat resembles a berry, each fruit containing two seeds of a semi-elliptical form.

It is generally supposed that the seeds of the coffee-tree will not germinate if they are dry when planted. If they are carefully dried, however, that is, if the mucilaginous part which covers the seed be not allowed to ferment, they will almost all germinate. It is better, however, to be on the safe side, and whenever it is possible to use fresh fruit. Of these the ripest and largest should be preferred.

It is better to separate the two seeds, which each berry generally contains, for, almost all of them will germinate without separation, germination will be more certain and the roots will grow straighter if they are separated.

Before sowing, the seeds should be put in water, and those that float should be rejected.

In an interesting article on coffee published in the *Mexican Agricultural Dictionary and Rural Economy*, various rules are given for improving the quality of the coffee-seed. Certain plants, called mother plants, are kept exclusively for seed; the best and largest fruits are selected; these are dried in the shade and otherwise carefully treated, so as to obtain seed of superior excellence. There is no doubt that the best seed will produce the best fruit, and that on this point, as on many others, coffee cultivation is susceptible of great improvement. All these rules may be found in the article referred to.

d. Sowing the Seed.—The ground being prepared in the manner already described, the seeds are to be sown, two by two, at intervals of a quarter of a yard. In each ridge four furrows are to be made, a quarter of a yard apart, and the plants in each furrow are to be set the same distance apart. The holes for sowing the seed may be made with the finger, half an inch deep; the seed being then covered lightly with earth. The whole ridge is then to be covered with grass or leaves, such as those of the wild plantain, or any other kind that may be suitable to prevent the seeds being washed away by the rains; but this should be done in such a way as not to exclude the moisture of the rain or the light and heat of the sun.

If any of this covering should still remain when the coffee begins to sprout, it is to be carefully removed; and if it should decay before the coffee appears above the ground, it is to be replaced by another covering.

e. Replanting.—Replanting is generally necessary, particularly when the nursery is formed from seeds, as some of the seeds do not germinate, and the young plants often wither shortly after appearing above ground. It will be necessary, therefore, to have near-by a seed-plot, from which the plants required to replace these may be taken without loss of time.

f. Cultivation.—When two plants spring up together in the nursery, the most robust is to be left and the other is to be transplanted to a place previously prepared for the purpose.

When the plants have appeared above the ground, the only care they require is that the nursery be kept free from weeds. Any other vegetation that appears must be pulled up by the hand, without employing a knife, machete, spade, or other instrument, as any of these might seriously injure the stalks and roots of the young plants.

It is not necessary to water the nursery in Soconusco, as the rains are sufficient for the purpose.

g. Pruning.—As soon as the young plant begins to send forth shoots, that is, about six months after planting, all shoots are to be cut off with the exception of one, care being taken that this be the most robust. In no case should the young plants be pruned in any other manner.

h. Time for Transplanting.—In Soconusco the nursery is long in attaining the growth necessary for transplanting—from eighteen months to two years. In Ceylon transplanting takes place a year after planting. Perhaps this difference is because the young trees are transplanted there much younger than here.

In Soconusco and Guatemala, transplantation does not take place until the plants are of from three to four crosses, as they say here, that is, until they have six or eight branches, which, growing in opposite directions, take the form of a cross.

E. Nursery Formed from Young Plants.—In forming this nursery the same rules are to be observed as those given for the nursery formed from seeds, with the modifications to be indicated farther on.

Planting is done in Soconusco in the early part of May, that is, when the rainy season has well set in, the planter being always guided by the rains in this operation.

The holes for the plants are to be made a quarter of a yard apart, with a pointed stick, half an inch in thickness. Four inches from the point of this stick, a second and thinner stick, half a yard in length, is to be fastened crosswise. This rude implement has two objects: 1. That the holes may not be made too deep, for the tender roots of the plant would perish if they remained in a vacuum. 2. That, the point of the first being in the centre of the second stick, the two ends of the latter may mark off the distance of one quarter yard on either side of the first, a hole being thus made and the places marked for two other holes by the same operation.

To form the nursery from young plants the seed-plot is absolutely necessary, unless there should happen to be some neglected plantation in the neighborhood which might furnish those required. When the fruits are not all picked from the trees those that fall to the ground sprout, and, if the plantation is not weeded, become in due time trees which may be transplanted to the nursery. It is better, however, to make a seed-plot, as the plants grow better and with greater luxuriance in it than in the shade of the trees.

F. Nursery Formed from Slips.—In some localities that I have visited, the nurseries instead of being formed from seeds of very young plants, are formed from trees a year old or more, which generally have a slender trunk and little foliage; the trunk is cut off to about eight inches above the root; the main root and the lateral roots are also pruned; at the end of a year this plant will have put forth shoots, will have a thriving appearance, and will be in good condition for transplanting.

I think the system of forming the plantation from plants grown from seed the best, however.

G. Nursery of Plants for Selling.—When there is no nursery at hand, in the locality where a plantation is to be formed, it is necessary to make one; this will require in some localities as long as two years. To avoid this delay it will be better to buy the plants already old enough to be transplanted.

When these are scarce, as is generally the case here, a very high price must sometimes be paid for them. Thus it is that nurseries are sometimes formed for the purpose of raising plants for sale; and this is sometimes a very lucrative business. In Guatemala coffee plants in good condition for planting have brought as much as $40 per thousand. In Soconusco, plants in good condition have been sold as high as $15 per thousand. Plants that have grown up wild have been sold here at prices ranging from fifty cents to $5 per thousand.

As the total cost per thousand of raising plants from seed does not exceed $2.50, it will at once be seen that the business of keeping nurseries for the sale of young plants is a profitable one, and at the same time one by which coffee cultivation is favored and facilitated.

H. Nurseries in Ceylon.—In Ceylon a piece of virgin land of the best kind, level if possible, and near the water for convenience in irrigation, is chosen for the nursery. This is cleared; the trunks of all but the largest trees are removed. The ground is dug up to a depth of nine or ten inches, and then laid out in ridges, with narrow paths between them.

Coffee in the hull, generally taken from the tanks after it has been pulled, is used for seed; it is planted in furrows about six inches apart.

In planting the furrows a cord, stretched from end to end of the piece of ground intended for the nursery, is used for measurement. An opening an inch or two in depth is made the whole length of the furrow, and the seeds are deposited in it an inch apart, and covered lightly with earth of the best quality. This done, the cord is taken to the next furrow, where the same operation is repeated.

The necessary drains to prevent the rains from injuring the plants are then made.

The young plant soon appears above the ground, and at the end of a year it is ready to transplant.

When the plants spring up very close together, some of them are taken up and planted in the next ridge. In this operation care must be taken that the tap root of the young plant be not bent; to avoid this a stick is used to make the hole which is to receive the plant. Care must also be taken that no hollow space remain about the root, for if this should be the case, the water would settle in it and rot the root. To avoid these dangers, and when the main root is very long, that part of it which seems most flexible is cut off obliquely with a sharp knife.

A bushel of coffee in the hull will produce 30,000 plants.

3. PREPARATION OF THE GROUND FOR PLANTING COFFEE.

The preparation of the ground for planting coffee includes the following operations:

A.—Felling the trees.
B.—Simultaneous sowing.
C.—Forming of a plan for the plantation.
D.—Staking.
E.—Digging holes.

Each of these operations will receive due consideration.

A. Felling the Trees.—Virgin soil being preferable, as has been already said, for making the plantation, the first thing to be done is to clear it, an operation which is performed about the beginning of December, when the dry season begins in Soconusco. The trunks of the trees as well as their layer branches must be chopped in pieces as soon as they are felled. The cutting should begin as soon as the trees are felled, for, as has been already observed, they are much easier to put up when green than when dry. The clearing of the ground should be finished by the end of February, the three operations here called "stubbing," "hewing," and "chopping" having been performed in the manner already pointed out in speaking of the nature of the ground suitable for the nursery.

When the trees are planted in broken ground, the process of clearing the ground should be performed from below up, for otherwise the trees felled would present great obstacles to the work of clearing.

Dead trees should not be left standing, for if blown down by the wind they would seriously injure the plants on which they might fall.

The trunks and branches of trees that decay slowly should be piled between the furrows, in order that they may not interfere with the work of planting.

In many places the custom prevails of clearing the ground by felling and chopping the trees in the dry season and burning the fragments when they are dry, so that they may not be an impediment to the work of planting.

The advantages of this system are the following:

1. The staking and the other operations of planting are greatly facilitated, as the ground is left clear and free from obstacles.

2. The burned ground produces fewer weeds, as the outer crust of the ground is calcined, and the cost of keeping it free from weeds is thereby lessened.

On the other hand, the objections to burning the ground are as follows:

1. The richest and best part of the soil, which is that of the surface, is burned out and is therefore lost, at least for some time.

2. The quantity of ashes that remains is injurious to the coffee, while, on the other hand, if the fragments of trees and bushes are left

to decay they will in process of time be converted into a fertilizer, which will enrich the soil and prove highly beneficial to the coffee.

For this reason, therefore, it seems preferable not to burn the ground.

B. Simultaneous Sowing.—The custom prevails in Soconusco of sowing corn at the beginning of the rainy season, as soon as the ground is cleared and the waste matter burned, and shortly afterward laying out the plantation. It is true that in this way the slight advantage is gained of utilizing ground already prepared for the cultivation of the corn; but, in exchange, the corn draws from the earth some of the elements required by the coffee for its development, for which reason it is better not to plant corn in land intended for coffee, but to leave for the exclusive benefit of this all the elements which the ground contains.

C. Forming of a Plan for a Plantation.—The work of gathering the fruit will be greatly facilitated if the plantation be divided into squares of from twenty-five to thirty cuerdas each, making them, whenever possible, accessible on every side.

In some estates the plantation is divided into squares of smaller dimensions; but the size mentioned satisfies every requirement. Between the squares a path, five yards wide, available for carts, should, if possible, be left.

In level ground this operation is very simple, but even there it would be well to lay out a plan showing the situation of the various parts of the plantation, the roads, etc., but this will be of even greater utility when the ground is hilly.

Without such a plan there would be the danger of planting trees in places where the paths would have to pass, which would cause the useless expense of planting trees that would afterwards have to be uprooted, besides the loss of the time occupied in their growth.

4. TRANSPLANTING.

Transplanting coffee, or setting the trees in their places, which is the operation that follows the opening of the holes, is done in one of three ways, to be indicated further on.

A.—Time for transplanting.

B.—Transplanting with the earth adhering to the roots.

C.—Transplanting with the roots free from earth.
D.—Transplanting in slips.
E.—Transplanting in Ceylon.

Each of the methods of transplanting mentioned, and the time for performing it, will be considered separately.

A. Time for Transplanting.—Transplanting is to be begun as soon as the rainy season has set in. The trees which are transplanted at the beginning of the rainy season will have the advantage of the rains during the whole of the season, and will take firmer root and thrive better than those that are transplanted in the middle, or at the end of the season.

B. Transplanting with the Earth adhering to the Roots.—Taking up in their order the different points relating to this manner of transplanting, the following will now be considered:

a.—Advantages of transplanting with the earth adhering to the roots.
b.—Method of transplanting with the earth adhering to the roots.
c.—Quantity of earth adhering to the roots.
d.—Size of the plants at the time of transplanting.
e.—Pruning the root of the plant in transplanting.

Each of these points will be considered separately.

a. Advantages of Transplanting with the Earth adhering to the Roots.—Planting should be done in this manner whenever it is possible, as the plant then scarcely suffers any disturbance consequent to transplanting. It has been observed that when trees already bearing fruit have been transplanted with the earth adhering to the roots, the tree has suffered so little that it has not lost even its fruit.

To plant coffee with the earth adhering to the roots it will be necessary to have the nursery very near the plantation, as otherwise the transportation of the plants would be a slow and costly operation, and the earth would fall away in transporting the plants to a distance, leaving the roots bare. The safest way, therefore, is first to lay out the nursery, and when the plants are of a suitable size to transplant, which, in Soconusco, is generally at the end of a year and a half, or two years, to transplant them with the earth adhering to the roots. If this be done it is certain that a year after transplanting the plant will yield its first crop.

Transplanting with the earth adhering to the roots is more expensive, and requires more hands than when done with the roots bare. For these reasons, in Ceylon, coffee is transplanted in the former and not in the latter manner.

b. Manner of Transplanting with the Earth adhering to the Roots.—When the ground is hilly, transplanting should be begun in the lower part of the plantation, and from thence continued upward.

In transplanting in this manner, the root of the plant is placed in the hole made for it beforehand, the plant being held upright in one hand while the hole is filled in with earth with the other. When filling the hole, the earth is to be pressed with the hand around the root of the plant, care being taken not to detach the soil from it. After the hole has been filled in, the earth is to be pressed down with the foot.

Should the earth around the root be crumbly it should be enveloped with large leaves, which should be tied around it to prevent its falling apart.

Sometimes the leaves are removed before planting the tree, but, in my opinion, it is better not to remove them, as they will serve as a good vegetable manure.

The trees should be transported from the nursery to the plantation by hand, or on the shoulders of men, placing the trees in a species of barrow made of their branches, each barrow containing from ten to thirty plants, according to the quantity of earth adhering to the roots.

To fill in the hole, earth from the surface of the ground is to be preferred to that which was dug out of the hole, as the former is always better. Special care should be taken to observe this rule when the soil is poor.

The men who perform the transplanting must be closely watched, to make sure that the work is well done, for if badly transplanted the plants would wither, or at least would be a year later in bearing. In no case should transplanting be done by the job.

c. Quantity of Earth adhering to the Roots.—The quantity of earth adhering to the root, will depend on the size of the plant that is to be transplanted, and on the nature of the ground where the nursery is made.

When the plants that are to be transplanted are small—and farther on it will be shown that it is advisable to transplant them while small—about four inches of earth on either side may be left on the root.

When the plants are large, or when the soil of the nursery is very loose, sufficient earth should be left on the roots to avoid the danger of its falling away and leaving them bare. Seven inches on each side would be a suitable size.

d. Size of the Plants at the Time of Transplanting.—The plants at the time of transplanting should be small; that is, they should be of two or three crosses, as they then take root more readily, and grow better and quicker.

The plants should be transplanted very young, however, only when the plantation can be kept free from weeds and when the soil of the nursery is black, in which case it has little consistency. When these conditions do not occur, the plants should be transplanted when they are of four or five crosses.

e. Pruning the Root of the Plant in Transplanting.—The plants should not be pruned at the time of transplanting them.

The principal root of the plant, however, should be cut off level with the earth adhering to it, and in case this should fall away, leaving the roots bare, the main root should be shortened until it is of sufficient thickness not to bend; for, as has been already said, if this happens the tree will die, or will not produce fruit.

Some believe that when the tap root is pruned the plant will stop growing vertically, but will send out small roots on either side. I cannot speak with certainty on this point; but if such be the case it would be better not to prune the root, for the deeper this strikes into the ground the better able the plant will be to bear the dry season without requiring irrigation.

C. Transplanting with the Root free from Earth.—Trees are said in Soconusco to be set or transplanted with the roots bare when they are taken from the nursery or the place where they have grown up without any of the soil adhering to the roots, or when, on taking them out of the ground, the earth has fallen off, leaving the roots bare.

The following points with reference to this manner of planting will now be considered:

a.—Manner of planting coffee-trees with the roots bare.

b.—Disadvantage of transplanting coffee-trees with the roots bare.

c.—Case in which planting should be done with the roots bare.

Each of these points will be considered separately.

a. Manner of Planting Coffee-Trees with the Roots Bare.—In transplanting with the roots bare the same rules are to be observed as in transplanting with the earth adhering to the roots, it being observed that in the former case the earth must be pressed much more compactly around the root than in the latter, and if so the plant cannot be pulled up without great effort; this shows that it is well planted.

Care should be taken not to expose the young plants that are to be transplanted to the heat of the sun, which would wither them; they should be placed in the shade and their roots kept moist.

The operation of planting with the roots bare is sometimes simplified by omitting the digging of the holes. A long-pointed stick is driven into the ground in the place where the plant is to be set, this is placed in the hole thus made, the hole is filled with earth, and another hole is then made close beside the first with the same stick, so that the earth in the first hole shall be firmly compressed. In order to ascertain whether the plant has been successfully transplanted or not a slight effort should be made to pull it up, and if it offers some resistance it may be considered well planted. A man can plant in this manner from 80 to 150 plants a day. With this system several operations are shortened and the cost of planting is less. It has the disadvantage, however, that a vacant space almost always remains around the root, where the water gathers, sometimes causing the roots to decay. The roots are also more likely to deteriorate with this system than with the other.

b. Disadvantages of Transplanting with the Roots Bare.—When the planting is done with the roots bare, the plant suffers greatly from the disturbance caused by transplanting, and a year generally elapses before it returns to the condition in which it was when transplanted.

It is evident, therefore, that if the plant is put back a year by transplanting, this year might have been better spent in the nursery than in the plantation, for the reason that it would cost less to keep the ground free from weeds in the former case than in the latter, and that at the end of the year transplanting might be done with the earth attached to the roots.

Many planters, with the object of saving the year and a half or two years which the young plant would spend in the nursery, form their plantations with wild plants or plants taken from a nursery already formed, the planting being done with the roots bare, the distance of the place from which they are taken admitting of no other manner. This is a false economy of time, for in order to save a few months of care of the nursery, the whole year which the plants thus transplanted are put back is lost, and the heavy expense is incurred of from four to six weedings of the whole plantation.

c. Case in which Transplanting should be done with the Roots Bare.—The only case in which trees should be planted with the roots bare is when, from the distance between the place where they have been grown and the plantation, it would be difficult if not impossible to transport them to it with the earth attached to the roots.

D. Transplanting in Slips.—When the young plants for the plantation are taken neither from the nursery nor from an abandoned plantation, but from trees already grown, it is said that the plantation is formed from slips. The trunk is generally cut off eight or ten inches above the root, in order that it may grow more vigorously. This kind of planting is always done with the roots bare.

Transplanting in slips is the least advisable way of all, and should never be adopted except when there is no other way of forming the plantation. In some cases, however, it has given good results.

E. Transplanting in Ceylon.—Transplanting coffee plants in Ceylon is performed, according to Mr. Sabonadière, in the following manner: The young plants grown in the nursery are pulled up with the hand; those that have crooked roots are thrown away as useless; with a sharp knife the flexible part of the tap root is cut off; and the lateral roots are also shortened, as they are generally very long, and this trimming prevents them from becoming tangled in the transplanting, which would cause them to decay. The hole is then filled in with the earth that has been removed from it, care being taken to put no stones in with it and to keep the tap root from bending and the lateral roots from tangling. The plant should be set no deeper in the ground than it was in the nursery. When the hole is filled the earth must be pressed down with the hands and afterwards with the foot. To be sure that the plant has been firmly planted it is smartly pulled, and if it offers resistance it may be considered well planted. Care should be taken to leave no hollow spaces around the roots, as the water would settle in them and would rot the roots. Beside each plant a stake is to be set to support it and to prevent its being pulled up when the ground is being weeded; if the plant should die the stake will mark the place where the plant that is to replace it is to be set.

Stakes are indispensable in Ceylon, for without them the young plants would be unable to resist the violence of the winds. The stakes are four or five feet in length and last two years. They should be driven at least eighteen inches into the ground. The plant is fastened to the stake with a cord in such a manner as that the bark shall not be injured by the friction of the cord against it.

5. CULTIVATION OF COFFEE.

The various operations which coffee culture requires in Soconusco will be first considered, a description of the manner in which the same operation is performed in Ceylon being appended in each case. Then the operations that are not considered necessary here but are customary in Ceylon will be described. The following points, then, will now be considered:

A.—Clearing the ground.
B.—Replanting.
C.—Pruning.
D.—Cultivation of coffee in Ceylon.

Each of these operations will be considered separately.

A. Clearing the Ground.—Clearing the ground, or weeding, consists in destroying the weeds and other vegetation that may spring up in the plantation, in order that the coffee-trees may absorb all the nutritive elements of the soil.

The following points regarding weeding will now be considered:

a.—Necessity and advantages of weeding.
b.—Manner of weeding.
c.—Number of weedings to be made during the year.
d.—Weeding in Ceylon.

Each of these subjects will be separately considered.

a. Necessity and Advantages of Weeding.—The transplanting having been done in May and June, which are the best months in Soconusco for this operation, the trees will have the advantage of the whole of the rainy season, and will yield their first crop in September of the following year, unless the plants were very young at the time of transplanting and weeding was neglected. The time occupied in the cultivation of the coffee-trees, then, in the sense in which the word is used here, will be from sixteen to seventeen months, during which the chief work will be the weeding.

The chief labor in the cultivation of coffee will be the frequent weeding of the ground for the purpose of destroying all the vegetation that may spring up in it. The secret of success in coffee culture consists in allowing no other vegetation to remain in the ground where coffee is planted.

If the plantation is not weeded, the weeds will choke the coffee plants; and if the weedings are not performed with the required frequency, the crops will be very scanty.

b. Manner of Weeding.—Thus far no machine or implement to facilitate weeding has been used that has not injured the plant. In some of the plantations of Guatemala clutivators or ploughs are used for weeding, but aside from the fact that these implements can be used only on level ground, many are of opinion that they injure the tender roots which the coffee plant sends out near the surface of the ground, for which reason these implements are very little used. Besides which, three or four years after transplanting, the branches of the trees will have spread so much that it would be impossible for the mules or oxen drawing the plough to pass under them without injuring them greatly.

For the reasons above mentioned the hoe is little used in weeding, for, in addition to cutting the young roots of the coffee-tree, it loosens the soil, thus exposing it to be washed away by the rains—a very serious objection in hilly ground. For these reasons, as a general rule, only the machete is used in weeding. In Ceylon a means has been discovered of preventing the rains from washing the earth away in hilly ground, as will be seen farther on.

c. Number of Weedings to be Made during the Year.—In the first year after transplanting the ground must be frequently weeded, for, as from their diminutive size, the plants cast scarcely any shade, the ground is almost completely exposed to the sun, and this causes it to produce abundantly all sorts of weeds. As the plant grows it casts more and more shade, and the greater the shade the smaller the area of ground exposed to the fecundating action of the sun, and consequently, the fewer will be the weeds.

The number of weedings which the plantation is to receive during the first year and subsequent years will depend upon various circumstances, such as the altitude of the ground, its temperature, the nature of the soil, whether it has been virgin soil or soil that had been already cultivated, etc., and in each case will be determined according to the particular circumstances of the place. Generally, four weedings a year are made, although in some localities six, and even more, are given. It will be seen at once that this is the most costly operation on the plantation.

d. Weeding in Ceylon.—In Ceylon, as in Soconusco, weeding the ground constitutes the principal expense of coffee cultivation. Mr. Sabonadière advises weeding the plantations once a month, and this advice seems to me very judicious, as in this way the weeds are not given time to grow or produce seed. The cost of twelve weedings a year would thus be about the same as that of six, because, in the former case there being fewer weeds and the work of uprooting them being less, two cords might be given to each laborer as a task, while in the latter case only one cord could be given him.

There is the objection, however, that frequent weeding stirs up the soil and exposes it to being washed away by the rains. This difficulty might to a certain extent be obviated if, in new plantations, where there are as yet few weeds, the weeds were uprooted with a sharp stick and thrown into a bag which the laborer carried with him, gathered in a heap, and burned when dry. But in old plantations this system cannot be followed; the hoe is there used, and the earth is of necessity turned up.

Sometimes the weeding is done from the trunk of the tree out, and a sort of bank or ridge is thus formed between the furrows, causing the rain-water to run near the trunks of the trees and carry away the earth from their roots. To avoid this inconvenience, the weeding ought to be done from the middle of the furrows towards the trees, care being taken that their roots remain well covered with earth.

Weeding is generally done in Ceylon by contract, the weeding of each acre of ground, or a little more than nine cords, costing on an average thirty-six shillings, or nine dollars, or about a dollar per cord yearly. Women and children perform the weeding.

B. Replanting.—It frequently happens that some of the trees, from having been badly transplanted, or for some other reason, either die or become sickly. If many plants should suffer in this way, the cause should be ascertained in order to remedy it. The best means of doing this is to dig around the root of a tree to see if the tap root has become bent, if it has come in contact with a stone, or if some insect be not injuring it.

The necessity of constantly replacing the trees which die, or decline, makes it indispensable to have always on the estate nurseries from whence plants may be taken to replace those that have died or deteriorated.

C. Pruning.—Pruning having an important bearing on the success of a plantation, the following points connected with this subject will now be considered:

a.—General considerations on pruning.
b.—Principles of pruning.
c.—Advantages of pruning.
d.—Topping.
e.—Pruning.
f.—Rules for pruning.
g.—Manner of pruning.
h.—Time of pruning.

Each of these points will be considered separately.

a. General Considerations on Pruning.—At first sight it might seem that pruning would be prejudicial to the trees, since it may be said that this operation is contrary to nature, which has given the trees their branches and their appointed size, which should neither be reduced nor diminished by artificial means. Experience has demonstrated, however, that it is better to prune the trees, for if these are planted in their native zone, the force of their sap is so great that if it be not suitably directed, they become in a short time a tangle of branches which the sun cannot penetrate, and thus lose their fructifying power.

From the time of Laborie, that is, for about eighty years past, pruning has been employed, and with very good success, to increase the productiveness of trees. According to this writer, pruning consists in cutting from plants whatever in them deviates from natural symmetry, and preserving what is in accordance with it, directing in this way the vegetative principle to purposes of order, profit, and regeneration.

It is a well-known fact that fruit-trees are greatly improved by pruning, and there is no reason why the system applied to them should not produce equally satisfactory results as applied to coffee plants.

The rule to be followed with regard to pruning will depend on each particular locality, upon the nature of the soil, the temperature, altitude above the level of the sea, exposure, etc., but the principle is the same; that is, to remedy the deviations of the tree from natural laws caused by conditions of soil, climate, situation, etc., and to make it return to those laws; art in this way aiding nature. Regarded in this way, pruning is as necessary as weeding.

b. Principles of Pruning.—For a better understanding of the advantages to be obtained by pruning, it will be well to define some facts and to lay down some rules concerning it.

The branches growing from the trunk of the tree are called primaries; those that grow from the primaries are called secondaries; those that grow from the secondaries, tertiaries, and so on successively.

Each branch of the tree bears fruit only once, sending out in the following year other branches which in their turn bear fruit.

Nature has so placed the primary branches that they receive an equal amount of light. Each pair of branches grows in a direction, with regard to the branch next to them, which deviates a few degrees from a right angle, so that if there are twenty pairs of branches no two of them will be found to be in the same vertical plane. This arrangement gives each primary branch a sufficiently large space for its development and sufficient amount of light. But when the vertical growth of the plant is checked by pruning this space becomes reduced to a circle of not more than three feet deep and about six feet in diameter.

As each branch gives but one crop, there would soon be no room for new branches to grow, if the old ones were not removed, for the secondary branches, after yielding their crop, would produce tertiary branches, these quaternary branches, and so on, successively, until the tree would be converted into a thicket of branches and unproductive foliage. The production of branches which give fruit takes place only when there is room for them to grow and light to make them grow.

In pruning there are two distinct operations, tapping and pruning, properly so called. The former consists in removing from the plant the upper part of its main stem or leader; and the second in cutting off some of its branches.

The upper shoots being cut off, the power of the sap before long causes two or three supplementary shoots to grow beneath the highest branches, and renews them as often as they are removed. These shoots being prevented from growing, as care must be taken to cut them off whenever they appear, the sap flows to the primary branches and makes them grow about three feet from the trunk. When the sap ceases to nourish the primary branches, it goes to nourish the secondary branches, and in the management of these consists the art of pruning and the success of the plantation.

The only permanent parts of the tree are the trunk and the primary branches. The trunk should grow straight and thick, and the primary branches should be strong and straight, and should grow at right angles with the trunk. If a primary branch should die or grow sickly it cannot be replaced.

c. Advantages of Pruning.—The advantages of pruning, to sum up, are the following:

1. It gives the tree an artificial form which makes it suffer less in situations in which it is exposed to the winds.
2. It makes the gathering of the crop easier and cheaper.
3. It increases the yield of the tree.
4. It regularizes the crop.

The branches which are exposed to the sun and air are those which bear the best fruit. Consequently, the more closely the tree is pruned, the larger the crops it will yield. This is seen better in the new trees, which bear more fruit in their second and third crops, because they then have fewer branches.

Generally, the trees give a bad and a good crop alternately. This evil may be remedied by pruning, as will be seen farther on.

Pruning is most required in high localities which are exposed to the cold winds.

d. Topping.—Topping consists in cutting off the top of the trunk or the leader of the plant.

This is the only kind of pruning practicable in Soconusco, and it is done arbitrarily and without following any rule. Farther on it will be seen that once the coffee plant has been thus cut, it will be indispensable to prune it.

When the trees have attained their ordinary height, that is, when they are about six feet high, their leader, or central branch, which is of little importance, is pruned, and also all the shoots that spring up near the roots. This stops the vertical growth of the plant, causing the branches to spread horizontally, sending out new branches which bear fruit, or strengthening the branches which it has already sent out.

Trees not thus pruned will grow as high as ten or eleven feet, and I have sometimes seen them as much as twelve feet high; but cutting stops the vertical growth of the tree, which then grows horizontally and through its branches.

The principal reasons in favor of cutting the leader are, according to Laborie, the following:

1. The fruit is brought by it within easy reach of the hand; it facilitates the gathering of the crops and prevents the branches from breaking when picking the fruit.
2. The tree acquires greater vigor as well under the ground as above it, and the trunk grows thicker.
3. The tree presents a smaller volume of resistance to the winds.
4. The tree loses none of its primary branches, but, on the contrary, these being nearer the source of vegetation, are better nourished and consequently more productive.

If the plant be pruned very near the highest primary branches, there is danger of the trunk splitting when the branches grow thick. This danger will disappear if the plant be pruned a little above the highest primary branches and these be removed.

The height at which the trees are to be left will depend in each case upon the distance apart at which they are planted, the nature of the ground, its altitude above the level of the sea, exposure, etc.

In Guatemala and Soconusco they are pruned to a height of six or eight feet.

In Ceylon plants are pruned to a height of two, three, three and a half, or at most four feet. Trees of more than four feet would not there be able to bear the violence of the wind. If the trunk is not topped they grow, in situations sheltered from the wind, to a height of ten or twelve feet.

e. Pruning.—The only kind of pruning that I have seen done in Soconusco is to cut all the shoots or branches which grow from the root of the tree, three months after transplanting, which operation is constantly repeated.

Cutting off the top of the tree causes the sap to produce numerous shoots which spring up in every direction. If these are allowed to grow, the tree will soon become a mass of tangled branches which the sun cannot penetrate, and will consequently have little capability of yielding fruit. The sap would produce numerous branches instead of being converted into fruit. Pruning is advantageous in every case, but it is still more so after the top of the tree has been cut off.

So many improvements have been made in pruning that there is now a complete system of pruning coffee-trees, which is, however, unfortunately unknown here. The best way of explaining this system is to give the rules which constitute it.

The difficulty of pruning lies in performing it so that the fruit will increase without exhausting the tree. It is the custom here to cure with clay the wounds caused by pruning.

f. Rules for Pruning.—The practical part of pruning is comprised in the rules which serve as a general guide for this operation. With the object of setting down all that I have found of value on this subject, I insert here, even at the risk of falling into repetitions, a *résumé* of the rules given by Laborie, Sabonadière, and a practical planter of Ceylon, and those published in the *Observer* of Colombo, the principal port of that island.

System of Laborie.—Laborie gives the following rules for pruning trees planted in good soil, in a hot climate, and which have been pruned before:

1. Every branch that looks sickly, that is broken, that has suffered any lesion, or that seems exhausted through over-production, is to be cut off.

2. Every branch that is decayed, withered, dry, or split, must also be cut off, following the principle of regeneration.

3. All vertical branches, branches that cross each other, or that do not grow in their natural direction, and all supernumerary branches which absorb the sap of the plant without producing fruit, are to be taken off, or, if very thick, sawed off.

4. The top and the middle part of the tree are to be pruned so as to give free access to the air and sun.

5. If, in spite of this, the tree should still be full of branches,

some of the secondary branches are to be cut off, choosing those that grow out of the natural direction, care being taken not to touch the primary branches.

This last rule should be followed, according to Laborie, only with trees in high lands and exposed to cold winds, these being generally full of branches and leaves. The twigs at the top, which run in every direction, are first to be taken off, then such of the larger branches as are crooked are cut off; and, finally, if the top or leader should be decayed, this decayed part is to be cut off.

All the primary branches that have kept their natural direction are to be left, for the reason mentioned above, that, once cut, they do not grow again. If they should be split or injured in any way, however, it would be better to cut them off. The same thing is to be done when they have taken a wrong direction, only the part being then cut that deviates from the natural direction.

In very cold localities, or when the trees produce very little fruit, because of their having too many branches, all the secondary branches are to be cut off, with the object of making new ones grow which shall bear fruit, and of giving a right direction to the sap.

When the primary branches have grown so long that they become interlaced with those of the neighboring trees, enough of them is to be cut off to prevent the branches from meeting.

After the tree has been pruned, any moss or parasites growing on its trunk are to be removed, using a wooden knife for the purpose.

System of Sabonadière.—The vertical shoots that first spring from the trunk of the tree should be taken off as they appear, without injuring the bark of the tree. Afterwards other shoots, as many as four in each bud, grow on the primary branches, in different directions. It will be advisable to remove these also, excepting one only in each branch, preferring that which is most vigorous and has the best direction. This operation is to be repeated every year, and will render pruning, properly speaking, or the removal of thick branches already formed which have some defects, unnecessary.

No secondary branch is to be left within six inches of the trunk, so that a vacant space, in the shape of a circle a foot in diameter, may be left around the trunk of the tree, in order that air and sunlight may circulate around it freely and prevent the growth on it of moss and parasites.

If the plantations are small the best system of pruning is to allow alternate secondary branches to fructify each year; that is, to cut those that have borne fruit one year, and leave those that have not borne fruit: but in large plantations it is difficult to follow this system, and in them the following rules should be observed:

1. To pull up all the shoots that are within a distance of six inches of the trunk of the tree.

2. To remove all the branches and shoots that grow toward the tree, or toward the other branches.

3. To reduce the number of shoots, leaving only one to each bud.

When the coffee-tree has not been pruned for some time, Mr. Sabonadière recommends that the primary branches nearest the ground be cut off, supporting his advice with these reasons:

1. They cause much humidity and shade, and prevent the free circulation of the air.

2. They rarely bear fruit, because of their superabundant leafage, and draw the nutritive sap from the tree unprofitably.

3. They interefere with the labors of cultivation, owing to their nearness to the ground, and they are injured by the laborers.

4. They cover the weeds and young coffee plants and serve as a hotbed for them.

No branch should be allowed to bear more than two, or at most three crops; when it has given these it should be removed, so that a new one may replace it which will bear fruit.

System of a Practical Cultivator of Ceylon.—This writer recommends that all the branches that are less than six inches from the trunk be cut off; that a vacant space of a foot in circumference be left around the trunk of the plant to permit a free circulation of light and air; and that one of every two secondary branches growing together be pruned, one on each side alternately of the primaries being left.

All the secondary branches that grow very near the trunk tend to debilitate the primaries, and the same is the case when they are allowed to grow in pairs.

Some set the rule that a primary branch should never be pruned; but this rule has its exceptions, as, for instance, when the branch splits or dies, or when it grows to such a length as to become intertwined with those of the neighboring trees. In this last case a part only of the branch should be pruned.

Some think also that when the primaries near the ground have grown to a great length and have become tangled they should be cut off up to the first good secondary branch, in order that this may receive all the sap that would otherwise go to nourish the branches that have been pruned.

System of the "Observer" of Colombo.—The natural consequences of the rules set forth, when speaking of the principles of pruning, which are in accordance with a notable article published in the *Observer* of Colombo, for June 17, 1861, are the following:

Being two different systems, they have some points in common.

All the secondary branches which are at a distance of less than nine or ten inches from the trunk of the tree, are to be removed. This will give the light access to the plant and will give the branches more room to grow.

Double or triple shoots shall be reduced to one, choosing that which grows at a right angle with the primary branch, and which lies in the same horizontal plane; the number of secondary branches on each side of the primaries will then be equalized, and, finally, the same number of secondaries will be left on each primary.

In deciding upon the number of secondary branches to be left on the tree, it must be borne in mind that if they be many the plant will become exhausted, and in the following year will produce fewer branches and less fruit. A number must be fixed upon, then, which, without exhausting the plant will cause it to yield good crops, and in this way the crops will be uniform, not as in plantations that are not pruned, which yield a fair crop one season and a bad one the next.

When the crop is gathered, all the secondary branches which have fructified to the extent of producing tertiary branches are to be cut off. Some advise that when there are enough branches to allow of it, all the secondaries that have produced fruit be cut off.

After the trees have been thus pruned, they send forth new shoots, which must also be pruned, as has been already indicated, as soon as they show the direction in which they are growing. If this pruning be deferred, it will be more difficult to perform, and the tree will be greatly injured by it, as it will then be deprived of its leaves when it most needs them.

The secondary branches must be cut off at their root, so that no part may be left that might send forth shoots in a direction other than the natural one, or cause the plant to sicken.

The number of branches to be left will depend upon the soil, climate, situation, etc.

When this system has been once established, it will be very easy to follow it, for the same thing that is done one year is repeated the succeeding years.

g. Manner of Pruning.—Laborie gives the following rules for the practical part of pruning:

1. To cut the trunk of a tree or any of its thick branches, a very sharp saw is to be used which can be managed with one hand, the trunk being firmly held with the other, to keep the tree from moving and to facilitate the work of sawing. The trunk must be cut obliquely from above downward, and the cut surface should face the north; the sun thus falls on it with less force and the rain will run off more easily, for, if the water should penetrate the wood, it would injure the tree greatly.

2. The large branches which cannot be easily pruned with a knife are to be sawed off in the manner above indicated. But the saw is to be used in no case in which a knife can be employed.

3. As the saw injures the bark around the cut surface, both the bark and the trunk of the tree should be trimmed off with the knife. When this is done, the wound heals more quickly and the bark grows better.

4. When the branches are pruned with the knife, the branch is to be held firmly with one hand, and with the other a sharp, quick blow is to be given it with the knife, from above downward. If the branch should not be severed at the first blow, this is to be repeated, bending the branch a little, but not so as to split it. If it should split, all the split part must be cut off.

5. The branch should always be cut close to its root.

6. When a secondary branch is pruned, this must be done very near its root, especially when it grows under another that has been already cut off.

7. To prevent many young shoots from growing in the place where a branch has been cut off, a piece of the bark is to be cut out at the top of the incision.

h. Time of Pruning.—Some planters prune the coffee-tree when it is two years old, or before it has borne fruit. It seems preferable, however, to prune it after it has reached maturity, that is, after it has given its first crop, for in this way it is not forced to produce a large crop, which would exhaust it.

Tapping should be done after the season of blossoming is over; for if it were done while the plant is in blossom the sap would go to produce blossoms and fruit, instead of strengthening and increasing the branches.

Pruning should begin immediately after the gathering of the crop and should be finished before the plant has begun to blossom.

Pruning is so essential to the success of a plantation that it should be suspended only for the four or five days during which the plant is flowering. It should then be performed with great care, so as not to destroy the flower, which contains the germ of the fruit; but it should not be altogether stopped.

After the flowering is over, the branches that have many blossoms should be left, and those that are exhausted and have few should be cut off.

The months of March, April, and May are the best months for pruning in Soconusco.

D. Cultivation of Coffee in Ceylon.—Coffee culture in Ceylon is much more complicated and costly than it is in Soconusco, as, in addition to the operations already described, with the modifications indicated when speaking of each of them, it is necessary to perform others also which are not customary in Soconusco, and the necessity for which has not yet been felt. These labors are the following:

a.—Making roads.
b.—Drainage.
c.—Making trenches.
d.—Loosening the earth.
e.—Making ridges.
f.—Irrigating.
g.—Destroying the insects which are enemies of the coffee-tree.
h.—Manuring the ground.

Each of these labors will be considered separately, that of manuring, which from its importance is deserving of special attention, being considered in a chapter by itself.

a. Making Roads.—It is desirable that the estate be traversed by cart roads, which shall place its different quarters in communication with the house in which the work of preparing the coffee for the market is performed. The transportation of the fruit, and of the fertilizers, when these are used, will be thus facilitated and rendered cheaper. The roads should not have a grade of more than ten per cent. The roads should be opened before the plantation is made, for, if they should be opened afterwards, many of the trees already planted and bearing fruit would have to be destroyed, and many of the neighboring plants would be injured by the work consequent on the opening of the road.

It is highly important that there should be easy means of communication between the various parts of the estate, so that the laborers may be able to get to their work without difficulty, and also that the superintendent or overseer may be able to go readily to the place where the workmen are employed, for if these know that they are not watched they will not be likely to work diligently.

It is an established fact that the trees near the roads are more vigorous and produce more fruit than those at some distance from them. The cause of this may be that the soil near the roads is looser than that of the rest of the plantation, and is renewed by means of the rains for which the roads form channels. This is another reason, therefore, which renders it advisable that there should be roads and paths in a plantation.

Mr. Sabonadière recommends that a road be made around the plantation with the object, among others, of separating it from the contiguous woods.

Although it may seem paradoxical to say so, it is really a saving to go to the expense of opening roads, for they lessen considerably the labor of cultivation.

The roads and paths should also be made to serve as channels to carry off the rains.

The ground in which coffee is planted in Ceylon is so hilly that frequently the roads can be made only in terraces. Mr. Sabonadière estimates the cost of making a path five feet wide, with a channel a foot wide, at £25 sterling, or $125 per mile, and that of a cart road, ten feet wide, with a channel eighteen inches wide, at $500 per mile.

b. Drainage.—It is advisable, in order to prevent the rains from washing away the richest soil of the plantation, to construct drains when making the roads, although this will require more capital and labor. The drains should be made before the plantation is laid out, for the reasons mentioned when speaking of roads.

Before enriching the soil with fertilizers means should be taken to preserve it—that is, to prevent the rains from washing away the richest part of it, and this is done by means of drains.

In Ceylon, and other places where coffee cultivation is most advanced, care is always taken to construct drains. Mr. Sabonadière recommends that these be fifteen inches in width and the same in depth; that they be distant from each other the space occupied by twenty trees, or about one hundred and twenty feet; that their grade be not more than one per cent., or even less, and that they run in the direction of the nearest ravine. Care should be taken to keep the drains always free from obstructions.

Mr. Sabonadière mentions an estate in Ceylon called Matelle, in which all the drains empty into a pit excavated in the lowest part of the ground, in which the soil washed away by the rains is deposited and afterwards carried to the plantation and scattered around the trunks of the trees.

c. Making Trenches.—In the estates of Ceylon where coffee culture is most advanced, a system is adopted which is entirely unknown in Soconusco, and which is at present considered unnecessary, but which I think it advisable to mention, as it might be adopted in some parts of Mexico with advantage.

It has for its object: 1st. To prevent the rains from washing away the soil. 2d. To prevent the water from standing around the roots of the trees. 3d. To augment the vegetable soil, which would be beneficial to the trees. The plan in question consists in making an excavation about three feet in length, a foot or a foot and a half in width, and the same in depth, between every four trees. The earth which is taken from these excavations is spread over the roots of the nearest trees.

These excavations serve not only to retain the rain-water and the soil which it carries with it, but also to receive the weeds cut down in weeding, the branches, twigs, and leaves that remain after pruning, and anything else at hand that will serve for manure. These excavations, therefore, will soon be filled; they should be cleaned twice a year, and the substances taken from them spread over the roots of the trees, making an excellent manure.

6. GATHERING OF THE CROP.

Under this head the following will be considered:

A.—Gathering the crop in Soconusco.
B.—Gathering the crop in Ceylon.

Each of these points will be considered separately.

A. Gathering the Crop in Soconusco.—In regard to the gathering of the crop in Soconusco and Guatemala the following points will be considered:

a.—Time at which the coffee-tree begins to bear fruit.
b.—Time during which the coffee-tree continues bearing fruit.
c.—Blossoming and fructification of the coffee-tree.
d.—Gathering the crop.

Each of these subjects will be considered separately.

a. Time at which the Coffee-Tree Begins to Bear Fruit.—The second year after its removal to the plantation the plant, providing it was of three or four crosses at the time of transplanting, will bear its first crop, called in Soconusco its trial crop, or first trial. In ground best suited to it and with careful cultivation, each tree will yield on an average four ounces. The following year, after transplanting, it gives its second crop, which as it is still small, as compared to those which it yields afterwards, is called in Soconusco its second trial. It may be considered that on an average, and under the conditions already mentioned, the yield of each tree will be one pound in its second trial. In the fourth year after transplantation it gives its best crop, which averages double that of the second crop, and in the succeeding years it will continue yielding good crops.

b. Time during which the Coffee-Tree Continues Bearing Fruit.—As the coffee plantations of Soconusco and Guatemala are of comparatively recent planting, the duration of the life of the coffee plant cannot yet be determined with exactness. Trees planted twenty-five or thirty years ago still preserve much of their vigor and luxuriance and yield good crops, although they have never been manured and hardly ever pruned. It has also been observed that trees planted in the high lands last much longer than those planted in the low lands.

Some planters are of opinion that the duration of the life of the coffee-tree depends on the shade which is given to it, and that when it is exposed to the sun it will live a shorter time than when protected by shade. In this regard what I have already pointed out is the case; that is, that a coffee plantation in low land, with shade, gives about the same yield as a plantation without shade on higher land or on land which has a lower temperature; and it is natural that it should last longer than a plantation planted in low land and also exposed to the sun.

c. Blossoming and Fructification of the Coffee-Tree.—In the month of January, in the low, and in March in the high lands, green buds appear on the branches of the coffee-tree which afterwards become white flowers, and later on fruit. At first the fruit is small and of a dark green color; as time passes it grows larger, and when it begins to ripen its color changes to a light green which, later, becomes whitish, then yellowish, and then red, of a light shade at first, and afterwards of a very deep shade. When the fruit is of this last color it is entirely ripe. If not picked at this stage the fruit drops from the tree like any other ripe fruit.

The time of the ripening of the fruit differs in the high and in the low lands, as has just been stated, as the power of the sun shortens considerably, in the latter, the operations of vegetation. While in plantations situated in low localities the fruit begins to ripen in September, and is all ripe in October, in lands situated three thousand or four thousand feet above the level of the sea, the fruit begins to ripen in November and continues to ripen gradually. In December not a single ripe fruit is to be found in plantations situated in the low lands, while in those situated in the high lands ripe fruit is still to be found in February and even in March.

It sometimes happens that in plantations situated as high as four thousand feet above the level of the sea ripe fruit is to be found on the trees all the year round.

This is another advantage of plantations situated in high lands, for when all the fruit ripens in the course of two or three weeks, as happens in the low lands, there is danger of losing a considerable part of the crop for want of hands—which are sometimes very difficult to procure, a danger which is greatly lessened or which does not exist at all when the picking of the fruit may be done during three months, instead of three weeks.

d. Gathering the Crop.—When the fruit is ripe it is to be picked by hand, and with the greatest care, in order not to pick the fruit near by which may not be quite ripe, or injure the branch on which it hangs.

When the trees are very tall, from not having been topped, it will be necessary to use ladders in picking the fruit.

In very large plantations it is necessary to construct cart roads to facilitate the transportation of the fruit to the place where it is to be prepared for market.

Women and children perform the labor of picking the fruit better than men.

The price paid for each measure of fruit picked varies in different localities, being higher, of course, where labor is scarce.

When the coffee-tree is not pruned it grows very tall. I have seen trees seventeen or eighteen feet high, with a radius, at the widest part of the top, of as many as twelve feet, the trunks of some of the largest being as much as five inches in diameter. In such cases the picking of the fruit is more difficult and costly.

The trees are at times so heavily laden with fruit that the branches break down under its weight. To prevent this it is necessary to support them with props.

B. Gathering the Crop in Ceylon.—To each laborer two sacks are given, a small one, which he fastens round his waist, and a large one, which he hangs somewhere near at hand. The first is to hold the fruit as it is picked from the tree, and the second to receive the contents of the first, every time it has been filled.

The trees are divided into rows and one or two rows are assigned to each laborer; so that he does not pick all the fruit of each tree, but only the fruit that is on his side of the tree.

In very hilly ground it is expedient to begin picking the fruit at the most elevated part of the plantation. The reason for this is that the fruit which falls can be more easily picked up, and that it is easier for the pickers to descend with their loads than to ascend with them.

An overseer is set over the pickers so that they may neither leave fruit that is ripe on the trees nor pick unripe fruit.

Care must be taken not to pluck the branch with the fruit from the tree.

A metal check is given to the pickers for each basket which they deliver, and on pay day they are paid according to the number of these checks which they return. This is done in Guatemala also.

The scarcity of hands and the importance of not losing the crop have suggested to the planters of Ceylon an easy manner of conveying the coffee from the trees to the place where it is to be prepared for the market. This consists in placing a galvanized-iron pipe where a stream of water may pass through it to the pulper, carrying the coffee with it. Mr. Sabonadière estimates the cost of such a pipe at from $1250 to $1500 per mile.

The fruit is received in a box of a certain measure, which is so placed that when it is full it can be easily emptied into the tank from which it is conveyed to the pulper. In this way the quantity of fruit received is known.

7. PREPARATION OF THE COFFEE FOR THE MARKET.

Under this head the following subjects will be considered:

A.—Preparation of coffee in Soconusco.

B.—Improvement in the preparation of coffee in Soconusco.

C.—Preparation of coffee in Ceylon.

Each of these points will be considered separately and as briefly as possible.

A. Preparation of Coffee in Soconusco.—Of all the operations relating to coffee the one which in my judgment is least advanced in Guatemala is its preparation for the market. There are not more than four or five estates where the preparation of the fruit is systematically performed and with an adequate saving of time, labor, and money.

I have not seen any estate in which all the operations of preparing the coffee are performed by machinery, that is, in which the ripe fruit is thrown into a general receptacle, from which it passes to others until it comes out sorted and graded, without the intervention of the hand of man, as is the case with wheat and flour, in the flour mills. There are estates, however, in which the operations of preparing the coffee are greatly simplified, the same water-power being used for all of them.

All the operations described below are employed in Guatemala; for in Soconusco not even the most necessary machines are used. So far the estate of El Malacate only has an iron pulper, a wooden retrilla, and a fan. The coffee is generally pulped on grinding stones and bruised in wooden mortars.

The preparation of coffee for the market includes the following operations:

a.—Pulping.
b.—Washing.
c.—Separating the good coffee from the bad.
d.—Exposure to the sun.
e.—Shelling.
f.—Dyeing.
g.—Winnowing.
h.—Sorting the coffee.

Each of these different operations will be treated of separately.

a. Pulping.—The coffee, when it arrives at the place where it is to be prepared for the market, is deposited in a tank full of water, which has a pipe leading to the pulper, into which the water, passing through the pipe, gradually carries it. As a general rule these machines are made of cast iron, and are almost everywhere hand motors, although they might easily be moved by the water used on the plantation.

The pulping machine removes the outer skin from the coffee and separates the two beans which each fruit as a general rule contains, with the exception of the kind called the pea berry, which has a single bean of an elliptical shape. The hull, or pulp, as it was called when treating of fertilizers, is thrown away, when it might be employed with advantage in manuring the ground.

Pulping machines have been in use since the time of Laborie, that is, some eighty years, although they were then constructed of wood; those now in use have not changed essentially in principle.

Mr. Sabonadière mentions the pulping machines which have exclusive privilege in England; these are the Butler, Wall, Walker, and Gordon machines. The last is the only one I have seen used in Guatemala. Mr. Sabonadière prefers the first.

b. Washing.—The coffee beans, now skinned and separated, when they leave the pulping machine fall into another tank full of water, in which they remain twenty-four hours, in order that they may be freed from a sweet mucilaginous substance of a light color which is found between the skin and the shell of the beans. With this object they are stirred about with a wooden shovel just before being removed from the tank.

c. Separating the Good Coffee from the Bad.—The perfect beans possess a higher specific gravity than water and sink in it; those which float are of poor quality and constitute what is called waste coffee, or coffee of the lowest grade.

In order to facilitate the separation of the perfect from the imperfect beans, a part of the principal tank is divided off, forming a second tank, smaller and lower than the first, so that the imperfect beans may be carried easily into it by the water or by the hand. It is better to construct the dividing wall of the two tanks of the same height as the others, and provide it with a small sluice, which, when opened, will establish a current that will carry the imperfect beans from the larger into the smaller tank. When the beans are thus separated, the process of preparing them for the market is conducted separately.

d. Exposure to the Sun.—When the beans have been pulped and washed they must be thoroughly dried, and this is effected by the action of the sun, which makes this process an exceedingly slow and costly one. A sort of threshing-floor is constructed which is paved with stone and mortar, and on this the coffee is exposed to the sun. The coffee must be taken in every day at sunset, or before, if the sky looks threatening, so that it may not be exposed to the rain or dew. In some estates the coffee is merely heaped up in a corner of the yard and covered with leaves or mats; but in such case it runs the risk of being stolen; and, besides, when the coffee is piled up there is danger of its fermenting, which would injure its quality. The coffee must also be constantly moved about while it is in the yard, in order that the sun may have access to every part of it and not to that only which is on top.

These operations, which are very tedious when the quantity of coffee to be dried is considerable, have to be continued for at least fifteen days, if the weather is fine, to dry the coffee thoroughly. If it is stored before it is perfectly dry, it may rot or at least become discolored, and lose greatly both in quality and price.

When the weather is cloudy or rainy, which often happens in mountainous lands situated at three thousand or four thousand feet above the level of the sea, where the sun is visible only for six or eight hours daily, the operation of drying the coffee is a much slower, and consequently a much more expensive one.

There is no operation in the preparation of coffee which may be so easily simplified as that of drying, performing it by means of artificial heat. Stoves for this purpose have been already invented in Guatemala, but thus far they have not given entirely satisfactory results. I believe, however, that the day is not far distant when some speedy, cheap, and efficacious means of drying coffee, other than the primitive one of exposing it to the sun's rays, will be discovered.

e. Shelling.—After the coffee has been pulped, washed, and dried, there is still another strong covering to be removed from it before it is ready for the market.

The alternate moisture and heat to which this covering is exposed during the operation of washing and drying the bean, causes it to contract and expand greatly, with the result that it becomes loosened from the bean and in many cases breaks, this greatly facilitating its removal.

Various instruments have been employed to facilitate this operation, but the one which has thus far given the best results is the "retrilla." This consists of one or two solid wheels of heavy wood, of from one and a half to two yards in diameter, and from eight to nine inches thick, set vertically, which are made to revolve over a species of circular box lined with wood, and are generally moved by oxen. In some plantations I have seen iron "retrillas," made in England, on the same model as the wooden ones, and moved by water.

The coffee in the husk is put into the box, and the wheel by its weight and its movement removes the coriaceous covering from the bean without breaking it, and loosens another thinner inner covering which resembles the filmy-like skin of an onion. Combined with the wheel is a sort of shovel which serves to move the coffee about.

f. Dyeing.—A bluish color in coffee, being highly esteemed in foreign markets, is given to it artificially on some estates by covering the surface of the wheels which hull the coffee with sheets of lead, which give it the desired color. If the demands of commerce render this color indispensable, some other substance might be employed to give it, which is free from the hygienic objections of lead.

g. Winnowing.—The coffee beans leave the machine mixed with the two coverings above mentioned. To separate them from these the fanner is used, and performs the operation quickly and efficaciously. Some fanners have the additional advantage of sorting the coffee, an operation which will now be described.

h. Sorting the Coffee.—The coffee being now perfectly clean must next be sorted, as the beans differ in size, shape, and color, and some are broken and others whole. As the different kinds of coffee differ greatly in price, it must be sent to market already classified, to obtain the highest price. Hence the necessity of sorting it.

This operation is performed almost everywhere by hand; but I have seen on some estates separating machines, which consist of various cylinders having holes of different sizes, through which the different kinds of coffee run out, similar, in principle, to the separators of flour in flour mills. Even when separating machines are employed, however, it will still be necessary to separate by hand the coffee beans of different colors, but there will now be very few of these.

American fanners are also employed, as has been said, in sorting the coffee.

In those estates in which this operation is performed with most care, the coffee is separated into five classes, as follows:

1st. Pea berry, which is considered the best.

2d. First-class, which includes the largest beans, all being of the same size and color.

3d. Second-class, including medium-sized beans.

4th. Third-class, including the smallest beans.

5th. Waste coffee, including beans of a bad color, broken beans, those that floated on the water and all those that cannot be included in any of the preceding classes.

When the operations mentioned have been all performed the coffee may be said to be ready for the market.

B. Improvement in the Preparation of Coffee in Soconusco.—In my opinion, the superior excellence of the Colima coffee, as compared with that grown in Soconusco, consists chiefly in the manner of its preparation.

In Colima the coffee is not first washed, as in Soconusco, thus removing the mucilaginous part of which mention has been made, but is allowed to dry with this substance on it. Thus the coffee absorbs a considerable part of the substance contained in the mucilage, which improves its aroma and its quality, while the advantages of said substance are entirely lost when the beans are first washed and thus deprived of it.

I believe, therefore, that the quality of Soconusco coffee would be greatly improved by following in its preparation the system followed in Colima, and probably in other places; that is, to allow the coffee beans to absorb, when drying, the saccharine substance which is found between them and their inner covering or shell.

C. Preparation of Coffee in Ceylon.—In the estates of Ceylon coffee is prepared for market in the same manner as in Soconusco, until it remains in the hull; it is then sent to the port of Colombo, where it receives the final preparation.

This is performed in the following manner: When the coffee is ripe, the sooner it is pulped the better, as, if this operation is delayed, the coffee becomes heated, which injures the color of the shell. In very dry weather it is sometimes necessary to sprinkle the coffee lightly with water a few hours before pulping it, as, if it were pulped dry the beans would break and the coffee lose in quality.

The pulping machines are moved in Ceylon by steam.

When the coffee leaves the pulping machine, it passes into large tanks paved and walled with stone, where it is kept until the mucilage remaining on it has fermented sufficiently. The time which it should remain in the tanks depends on the elevation of the plantation above the level of the sea, and the state of the temperature. At an altitude of three thousand feet, the coffee should be kept in the tanks for two days.

The receiving tanks have an opening at the bottom to allow the water to run out, in addition to the sluice through which the coffee passes from the receiving tank into the tank in which it is to be washed. When it is ready to be washed, the water is allowed to run into the receiving tank; the coffee is moved about with long-handled wooden shovels, two feet in length and nine inches in width, until there is sufficient water in the contiguous tank. When the coffee has passed into this tank the water is to be changed several times until the mucilaginous part is entirely removed and the parchment-like hull is of a yellowish-white color.

The tank in which the coffee is washed should be slightly inclined, so that the lighter beans and the husks may be carried to the lower end, where they are collected by means of sieves or baskets. The beans that float are allowed to pass into another lower tank, where all the coffee of inferior quality is collected.

After it has been washed, the coffee in the hull is heaped up on an inclined platform, to allow the water to run off, remaining there until the following morning, or longer, if the weather is wet. If the weather continues wet, the coffee is carried to the storehouse and spread on mats, spreading it out as much as the space will permit, so that the air may dry it. When the wet weather continues long and the storehouses are full, the coffee is allowed to remain on mats, fires being made to dry the air. The coffee is to be moved about continually, in order that it may not become heated; and it should even be sprinkled with water daily. When the wet weather continues very long, there is danger of the coffee being spoiled by becoming heated and germinating.

When the weather is dry and the sun hot, two days will be sufficient to prepare the coffee for sending it to the port of Colombo. When the coffee has been well washed and thoroughly dried immediately after being washed, it is of a light color and very lustrous.

Coffee of inferior quality and waste coffee are dried apart.

When the coffee is perfectly clean the bean assumes a bluish color which afterwards changes to a grayish green.

The final operations of preparing the coffee for market are performed in Colombo, and consist in drying the bean until it becomes very hard, removing from it the parchment-like hull and the pellicle underneath, cleansing it by means of a fanner, sorting the beans according to size and shape, and removing by hand black or broken beans.

The grades of Ceylon coffee are No. 1, No. 2, pea-berry and waste coffee.

Ceylon coffee is sent to market in casks or barrels. The coffee of Soconusco and Guatemala is sent to market in bags.

IV.

CONCLUSION.

I have endeavored to carry out, to the best of my ability, the object I had in view, in writing this work, that is, to facilitate and extend coffee cultivation in Mexico.

The facts which I have set down will, I believe, show that there are few enterprises that could be undertaken in our country with so much profit as the cultivation of coffee.

The coffee crop of Soconusco, last year (1873), did not reach, it is estimated, 1,500 quintals. The greater number of the plantations already formed, are situated in the low lands, which, as I have already said, are the least suitable for this crop. There seems to be a growing disposition, however, to plant coffee, and new plantations are being formed in the high lands. Persons have even come from other parts to plant coffee in Soconusco. Its production will consequently increase considerably within a very short time.

I have no data on which to base an estimate of the quantity of coffee produced in the other parts of the republic, where this crop is raised; but I imagine that the annual production, in the entire country, is about 100,000 quintals—which is little enough—the greater part of this being raised on the coast of Veracruz. Guatemala alone produces more than 200,000 quintals; and Costa Rica, whose population does not reach 200,000, very nearly 300,000 quintals.

Mexico possesses extensive lands suitable for coffee, which are now uncultivated, and which will make the fortunes of those who shall cultivate them, contributing at the same time to augment the national wealth. The day in which the cultivation of coffee assumes important proportions in Mexico there will be opened up for the country a new source of wealth, of agricultural industry, which will greatly increase its exports, and, as a consequence, its imports, its commercial activity, and even the national revenues, while enriching the planters.

I earnestly hope that this little work may contribute, in some degree, to the realization of these results.

M. ROMERO.

THE INDIA-RUBBER CULTURE IN MEXICO.

INTRODUCTION.

My desire in calling the attention of my fellow-citizens to the exploitation of a source of wealth which, I do not doubt, will, in a few years, assure their future, is the sole motive that induces me to write these lines, even at the risk of sometimes falling into an error of more or less importance. I trust that this explanation will serve as an excuse for the inaccuracies which may be found in this paper, and I shall consider my object in writing it attained, if competent and practical persons will kindly point out the gaps or defects that must be in it, so that the subject may be the more clearly explained.

DESCRIPTION OF THE RUBBER-TREE—BOTANICAL NAME—CHEMICAL ANALYSIS—SPECIFIC GRAVITY OF RUBBER—WHEN RUBBER WAS FIRST USED.

The tree that produces rubber belongs to the family of *Euphorbiaceæ* trees, shrubs, and grass that gives a milky juice.

I have seen a great many rubber-trees in Soconusco and in the western part of Guatemala contiguous to Mexico and near the sea; but they were nearly all small; the large ones had been cut down for reasons which will be mentioned later. There is a great difference between the size and shape of the leaves of the two varieties; both have them silky and of a deep green; the small trees are very straight, without leaves, except in the upper part, these being large, hanging down from a bough like a stem, and the bark is of a light color.

On the San Carlos farm of Mr. Jeronimo Manchinelli, in the jurisdiction of Tuxtla Chico, in the Soconusco district, I saw three trees that the owner had found growing on the place when he took possession of it, thirty-one years ago, and which he thinks cannot be less than thirty-five years old. They are of an enormous size; I measured the trunk of one of them; it was two metres in diameter, and the space shaded by its foliage had a diameter of at least twenty or twenty-five metres; its branches were also very large, the leaves smaller than those of the smaller trees and their form entirely different from them. Mr. Manchinelli having never extracted any rubber from them, did not know the quantity that each tree could give, but experts calculated that it could not produce less than about fifty pounds a year.

The trunk of the rubber-tree of Soconusco is of a spongy white wood, with large pores plainly visible to the eye.

Very little is known regarding the discovery of the rubber-tree. The French astronomers sent to Peru, in 1735, were the first who called attention to it. It was found afterward at Cayenne by Frisman, in 1751. Dr. Priestly refers to it in the preface of his work entitled *Prospective*, printed in 1770. Various experiments made for utilizing rubber are mentioned in the Memoirs of the Academy of Sciences of France for the year 1768.

Rubber is extracted by making an incision in the bark of the tree from which flows a liquid very much like sap in color and thickness. Exposed to the sun or the fire, the watery part evaporates and the rubber remains. Exposed to the air, it loses its white color and becomes dark.

This liquid is of a light yellow color with a specific gravity of 1012. The rubber separated from the sap rises to the surface like coagulated albumen, and when heated with water, its specific gravity is 0.925, but when pressed out like cream it contains 32 per cent. of the liquid.

From the analysis made by Prof. Faraday, rubber, as it flows from the trees, is composed as follows:

Water with a little free acid	56.37
Rubber or *caoutchouc*	31.70
Albumen	1.90
Wax	....
A body of nitrogen soluble in water	7.13
A substance insoluble in water	2.90
	100.00

According to the same scientist, rubber already dry contains none of the oxygen which is found in most vegetable products, but is an hydrocarburet consisting of eight parts of carbon and seven of hydrogen, which would require a proportion of 82.27 of carbon to 12.73 of hydrogen for every 100 parts. The quantities found by him were 87.02 of carbon to 12.08 of hydrogen. The same result was obtained in the analysis made by Dr. Ure.

IMPORTANCE OF RUBBER AS A RAW MATERIAL.

It is well known that rubber is used as a raw material, in the manufacture not only of water-proof goods, but also of many others which could not be produced as advantageously with any other substance.

Every year it is employed in the manufacture of a great many articles that were not made of that material the year before. It may, perhaps, not be an exaggeration to say, that in course of time it will partially supersede iron. These considerations are sufficient to establish the fact that the demand for rubber, in the markets of the world, far from diminishing, will, in the future, increase considerably.

It is extracted at the cost of the tree itself; either because this is cut down, owing to the belief that the sap is thus more abundant, or because of the frequency with which extractions are made, or of the bad system in use of making them, which injures the trunk and thus kills the tree. Notwithstanding that certain measures to protect it have been adopted in different countries, such as Honduras where a fine of fifty dollars is imposed for every rubber-tree destroyed on government lands, they have proved ineffectual.

The inevitable consequence of this must be that the production will diminish, unless a large number of plantations are soon established.

PROFITS OF THE CULTURE OF THE RUBBER-TREE.

The large profits yielded by the culture of rubber are obvious. Supposing, for instance, a plantation of ordinary size, containing about one hundred thousand trees, will give, at the end of a few years making a low estimate, six pounds of sap a year for every tree; that sap, reduced to rubber, would lose about one-half by evaporation, then each tree would yield three pounds net of rubber.

From the analysis made by Prof. Faraday, the sap contains only forty-four per cent. of rubber, the balance being composed of different substances; therefore, supposing that these evaporate, it will result that from one hundred pounds of sap forty-four pounds of rubber will remain. This conclusion agrees with the opinion of Dr. Ure, who, in his *Dictionary of Arts, Manufactures, and Mines*, says that in reducing the sap to rubber there remains forty-five per cent. of the latter, the balance of fifty-five per cent. being lost.

The number of pounds of sap furnished yearly by each tree being reduced to rubber on that basis, two pounds and a half of rubber would be obtained from each tree, or a revenue of two dollars and a half per tree, if the price was one dollar a pound; or of one dollar and twenty-five cents per tree, if the price was fifty cents a pound. In the first case, the plantation would give a return of two hundred and forty thousand dollars a year; and in the second of one hundred and twenty thousand. Admitting that this estimate of six pounds per tree is too high, let it be one-half, one-quarter, or even one-fourth of it, which would be the minimum yield, as will be seen further on, the returns of the plantation will be one hundred and twenty thousand dollars, eighty-six thousand dollars, and seventy thousand dollars, respectively, in the first case, that is to say, if the price of rubber was one dollar per pound; and sixty thousand, forty thousand, and thirty thousand, in the second case, if the price was fifty cents a pound.

It is to be observed, that sixty cents a pound is to-day the average price of rubber in foreign markets, and that, taking into account the expenses of transportation, commission, freight, insurance, and others, including also the profits of the exporter, which may be calculated at thirty per cent. of the price above mentioned, this would be reduced to forty-two cents per pound on the place of production.

It must be observed, moreover, that as the yield of every tree will increase annually, there is every reason to believe that a tree twenty years old will give from fifteen to twenty-five pounds of sap.

For the purpose of showing upon what basis the preceding calculations rest, and of giving general data that may be useful to those who would like to go into that business, we will consider in the following chapter, what are the requisite conditions to form such a plantation.

CLIMATE AND LAND BEST ADAPTED TO THE CULTURE OF THE RUBBER-TREE.

The fact that thus far rubber is not the product of a cultivated tree, does not preclude the possibility of one answering the question : What climate and land are best suited to its development ?

The best climate is the hottest, and the best land the dampest and the nearest to the seashore or to the low banks of rivers. Wherever rubber-trees are found these conditions are present.

Those of Pará are found on the banks of the Amazon. The rubber land that I have personally examined is in the Department of Soconusco, in the State of Chiapas. Soconusco forms a plain from six to twelve leagues wide, which terminates at the Pacific and ascends gradually and almost imperceptibly to the base of the Cordilleras, where the ascent is steeper, although still gradual. This plain is crossed by numerous rivers which come down from the Cordilleras and empty into the sea. The climate is hotter in the low than in the high lands above the sea-level. One notes the great number of rubber-trees,—all small ones, the large ones having been cut down to extract their sap,—that are in the forests on the plain, and the number increases notably as one approaches the sea, and diminishes in the same proportion as one goes from the shore toward the Cordilleras; even at the base of these mountains, at an elevation of twenty-five hundred feet above the sea-level, and in lands suitable for the culture of coffee, some rubber-trees are found, but they are exceedingly rare.

To establish a plantation it is necessary, before everything else, to select the ground; this should be in the climate best adapted to the development of the tree, as the expenses would be almost the same everywhere; while the trees will grow in much less time under favorable than under unfavorable conditions, and give greater returns when they begin to bear, in the former than in the latter case. In the District of Soconusco alone, there is sufficient land to plant several millions of rubber-trees; and I believe that a great many localities could be found on both sides of the coasts of Mexico, that are equally advantageous for that culture; provided, always, that the plantations are established in the low lands, in a damp climate, and, whenever possible, near the seashore or the banks of rivers. The temperature of the localities in Soconusco where the rubber-tree most abounds is from twenty-eight to thirty degrees Centigrade, or from eighty-three to eighty-seven degrees Fahrenheit. In all cases it would be well to form the plantation in places where the wild trees grow most abundantly, as their presence is the best evidence that the land and climate are favorable to their development.

Dr. Ure states that the Asiatic rubber, or *Ficus elastica*, is found at a very high altitude above the level of the sea.

This tree has, besides, the great advantage of requiring but little labor for its cultivation, which makes its exploitation possible, even on a large scale, in Mexican coasts, which are generally not populous.

HOW TO FORM A PLANTATION OF RUBBER-TREES.

In regard to the best method of forming a plantation it must be observed that the rubber-tree not being very delicate, economy of time and money are the first things to be considered. If the land selected be forest land, the first thing to be done is to clear it, should it be thought preferable to have the plantation exposed to the sun; but should the shade be deemed best, the trees already standing will furnish the best and cheapest protection. The soil having been prepared, the planting can begin by sowing the seeds in convenient places, or by transplanting young plants from the nursery or from the forest itself. Sowing the seeds would undoubtedly be the best plan, but it would also be the most expensive and the slowest; the most expensive because it would involve the cost of a double planting, the first in laying out the nursery, and the second in transplanting the young plants from the nursery to the plantation; the slowest, because the time that might be saved by planting saplings would thus be lost.

The method to be adopted will, therefore, depend upon circumstances. Where there are trees already somewhat grown it is preferable to transplant these, because it saves time; where there are large trees, cuttings may be used, and where there are none of either and only seeds can be obtained, the last must be used. It is not necessary that they should be sown in the nursery, as the plant is not delicate and requires no special care, like coffee and some others regarding which experience shows that it is an economy to plant them in the nursery.

On the 16th of September of the present year (1872), being at Tapachula, I made an experiment with Don Sebastian Escobar, a well-known practical agriculturist, thoroughly acquainted with the nature of these lands and enthusiastic in the matter of agricultural progress. We selected a part of the public domain occupied by Señor Escobar, to see whether transplanting could be done by pulling up the small trees, as in that case the roots would come up without any earth around them; or if it would be necessary to remove the soil that covered them; for in the first case, the operation would be quicker and cheaper than in the second. On the land referred to, we saw about sixty small rubber-trees, from eight decimetres to one metre and a half high. We pulled up a few without, and others with the earth covering their roots, and transplanted them at a distance of two metres from each other. We first performed the operation planting some of the trees in the shade, and then planting others in the sun. A short time afterward we noticed that the leaves of the transplanted trees had begun to fade; in the evening of that day, they appeared to be dead. On the day following, they were dry; shortly after they fell off, the branches that remained presenting a not very encouraging appearance. In a week, the trees all began to sprout again; a little later they were covered with luxuriant foliage and not a single one was lost. This is a proof of the endurance of the rubber-tree. The land in Tapachula, where the experiment was made, is not the best kind for the rubber-tree, being somewhat higher than that nearer the shore.

The easiest and most economical way of making such a plantation would be, in the beginning, to combine it with the culture of some product adaptable to the soil, and of a more rapid growth. The land being cleared, it could be prepared for sowing cotton, which generally grows well in the soil suitable for the rubber-tree; and, in sowing cotton, rubber could also be sown at proper distances, or saplings transplanted. The cotton crop being harvested, the rubber would remain without any cost, since the expenses incurred would be only those required for the cotton. This operation could be repeated the year following; and, in this way, the plantation would be gradually enlarged and without additional cost.

There is also another very economical way of planting rubber, and that is, to plant the trees as shade in the coffee and cocoa plantations. I have heard that this operation has been successfully tried in some places. The expenses of a plantation of rubber-trees would not then exceed, in any case, those required for one of coffee or cocoa; but the rubber-trees could not then be planted in the places best adapted for their rapid development and greatest yield, inasmuch as the climate and soil most advantageous for coffee and cocoa are not the best for rubber.

Señor Don José M. Chacón assured me that to have cuttings grow well, the end which is to go into the ground must be pointed, and the slip driven in, probably in order that the soil may adhere the better, and the cutting remain firmly planted.

It is to be observed that in the lands of Soconusco near the shores of the Pacific, seeds and trees somewhat grown are to be found in sufficient quantities to form extensive plantations.

DISTANCE NEEDED IN PLANTING RUBBER-TREES.

The distance apart at which rubber-trees should be planted, is a question which, although apparently secondary, is really an important one. If from a false economy they be planted closer than is proper, the trees will interfere with each other, and will consequently become stunted; while if planted a greater distance apart than is absolutely necessary, there will be a waste of ground and a great increase in the cost of cultivation, besides the cost of fencing, watching, and such other outlays as may be needed, when the plantation is in a state of full development and production. The importance of space is practically illustrated in coffee and sugar-cane plantations: it is seen that on the same land the returns of coffee-trees planted at a distance of three metres apart are double the returns of those growing at a metre and a half or two metres apart from each other. From this it will be perceived how great a difference in the yield of the rubber-tree the distance at which they are planted makes.

The prevailing opinion among the agriculturists of Soconusco, is that a space of two or two and a half metres from tree to tree, on every side, is all that is required. It seems to me that it ought to be much more. If coffee, which is a shrub seldom attaining a height of more than three or four metres, and whose foliage is, at most, three metres in diameter, requires in order to give an abundant crop to be planted at a distance of three yards from tree to tree, is it reasonable to suppose that the rubber-tree, which grows to a very large size, should be planted at the same distance or less?

In my opinion, planting ought not to be done at a distance of less than five metres, and even this would be too small for trees over thirty years old. The trunks of those on the farm of Mr. Manchinelli, which were of that age, measure, as I have already stated, two metres in diameter, and the circle formed by their foliage is between twenty and twenty-five feet in diameter.

The only objection there can be to leaving a greater space between the trees, and one which may, in some cases, be of sufficient weight to reduce it to less than five metres indicated as the best, is the necessity of economy, inasmuch as the cost of the grove would increase in proportion to the distance apart at which the trees are planted, as will be demonstrated in the following chapter.

CARE REQUIRED FOR THE CULTURE OF THE RUBBER-TREE.

The hardiness of the rubber-tree greatly simplifies its culture, and causes this to be proportionately cheap. In the low, hot, and damp lands favorable to its growth, fertility is so great that the labor consists, more than in anything else, in struggling against the luxuriance of the vegetation; and the principal expense is that of the frequent weedings which are necessary to prevent the underbrush and vines from destroying the grove, or causing the trees to grow slowly and to become stunted.

In the lands that are much higher than those favorable to the rubber-tree, but less fertile, being less hot and damp, like those that are suited to the coffee-plant, it is necessary to make as many as six weedings every year; one every sixty days, in order that the saplings may not be injured or destroyed by the undergrowth and parasites.

The rubber-tree has the great advantage of possessing a vitality superior to that of the weeds or of any other kind of vegetation, and for that reason it does not require the heavy expense of frequent weedings. The tree which, without any help from man, can grow in woods full of vines, briers, and other wild plants, can certainly outlive the weeds, for they will not grow more rapidly than it does.

There is no doubt that a grove of rubber-trees requiring to be weeded out only once after having been planted, will grow without that indispensable requirement in the low and fertile lands of the coast; but in that case, the growth of the tree will be slower, because the weeds will share with it the nourishment drawn from the soil; it would therefore be cheaper to weed the grove twice a year, according to the rapidity of the growth of the brush and the means of the owner.

In proportion as the tree grows larger weedings will become less necessary, because its foliage will cover a larger area of ground; and the larger the surface not exposed to the sun the less luxuriant will be the undergrowth. Viewed in this light, a rubber plantation with shade will be more profitable since it will require fewer weedings.

TIME REQUIRED FOR THE TREE TO PRODUCE RUBBER.

It is not possible to fix, with any degree of certainty, the time required by the tree before it will yield rubber, which is an important question, for supposing it to be fifteen or twenty years, the enterprise will not offer the same inducement as if it were but five or six years. Six years is a comparatively short period in a man's lifetime, and this is the time required by the coffee- and cocoa-plants to bear fruit. It is safe to say that were it perfectly certain that five or six years were sufficient for the rubber-tree to produce, the number of groves would increase considerably. The importance of this point has led me to give it particular attention.

Superficial observers, in the regions where the rubber-tree is found, believe that the time necessary for its development is not less than from twelve to twenty years. Those who are more experienced and closer observers fix a shorter term. After having heard many and widely differing opinions on this point from agriculturists and studied the question very carefully myself, I am inclined to think that six years, counting from the time the seed was planted, is the period required for the rubber-tree to yield its product, in the soil best suited to its development; for it is quite evident that in less favorable soil, it would need a longer time.

During my recent stay in Soconusco, I was able to satisfy myself by facts of the correctness of the opinion fixing six years for the development of the rubber-tree.

I frequently found trees whose age, owing to their being in a well-known spot, such as the courtyard of a farm, could be ascertained by asking it of the persons who had seen them planted or growing from the seed. This was sometimes difficult, but the difficulty could be removed in every case, and then it appeared that trees from six to eight metres high, with a trunk from six to eight inches in diameter, were three or four years old. This seemed to me conclusive evidence that a tree six years old would have attained the necessary growth to begin bearing without suffering any injury, provided always that it were situated in the best conditions of climate, soil, and cultivation.

Practical and experienced persons in the State of Veracruz have assured me that along its coast, bordering on the Gulf, six years are considered a sufficient period for the development of the rubber-tree.

QUANTITY OF RUBBER THAT EACH TREE CAN YIELD.

There is another question not less important than the preceding one; it relates to the quantity of rubber that each tree can yield yearly. There is also a great variety of opinions upon this subject. Many experienced agriculturists are of opinion that the trees can be tapped every two months without injury to them, yielding each time six pounds of rubber, which, in one year, would amount to thirty-six pounds; while there are others who think it imprudent to make more than one extraction every year, and from which not more than six pounds can be obtained. Between these two opinions, there are others differing both as to the number of tappings and the quantity of the yield. Finally, there are some who believe that extracting the sap every two years would give the same quantity as two tappings annually, but the proportion of rubber would be greater.

The information obtained from workmen who, for two years, have been engaged in Soconusco in extracting rubber, to the extent of destroying all the large trees, does not bear upon the question; for, in the first place, the trees used are much older, a great many of them being centenarians; and, in the second place, because they are cut down to obtain the sap. Their statements, moreover, refer to measures of capacity and not of weight, as will be shown later; for they first collect the rubber in gourds and afterwards pour it into jars. But even according to these statements, a tree having attained its proper dimensions in six years, and having had its sap extracted without being cut down, would produce a quantity of rubber weighing not less than six pounds.

It is to be observed, as has been already said, that in order to convert into rubber the sap that flows from the tree after making the incision, it is necessary to let the watery part evaporate, which, according to Prof. Faraday's analysis, which agrees with Dr. Ure's opinion, is as much as fifty-six per cent., the remaining forty-four per cent. being what is properly called rubber. Consequently, the sap coming from the tree must lose at least that quantity before being converted into rubber.

METHOD OF EXTRACTING RUBBER WITHOUT DESTROYING THE TREE.

The process of extracting the sap from the tree is also an important point in determining the success of a plantation. In Soconusco a method entirely primitive is used, which causes a great loss of sap, prevents this from being pure, and, what is worse, kills the tree. They begin by cutting down the tree, and then make various incisions across the trunk with a machete, at a distance of three spans (twenty-nine inches) from each other; this being done, leaves from the tree are placed below the incisions to collect the sap, which is afterward poured into a gourd, and finally put in the jar.

It seems to me that with so ruinous a system, less sap is obtained than if the tree had not been cut down; for I believe that, being no longer in a vertical position, the force of gravity which causes the sap to flow, ceases, and, consequently, the quantity drawn is less than if the tree had been left standing to receive the same number of incisions. When, by chance, they do not cut down the tree, they make only one or two incisions in it at about the height of a man's stature; it is then more difficult to collect the sap by the imperfect means of the leaves. With this process, it frequently happens that earth, dry leaves, small insects, and other foreign substances become mixed with the sap and remain in the rubber, making it impure, causing it to fall into discredit in the market, and greatly reducing its value.

Believing that a more advanced method of collecting the sap was used in Pará, I also made some inquiries upon the subject, to the United States Consul in that province. The information he sent me will be found further on.

It is evident, that to extract rubber properly, a more adequate instrument than a machete is required; and to collect the sap a better receptacle than the leaves used in Soconusco, or the clay used in Brazil. I think it very probable that such instruments, if they are not yet used, soon will be, in view of the need there is for them, and the advances that are being daily made in the manufacture of agricultural implements.

To prevent the tree from dying in consequence of the incisions referred to, it is indispensable to observe two things carefully: first, the incision must not go beyond the bark, for if the woody part is injured, the tree may die; second, such incision should not isolate the lower from the upper portion of the bark, as, in that case, the sap being unable to ascend to the upper part of the tree, this also would cause its death. It is also necessary that the tapping be not too frequent.

There are some who think that to yield a greater quantity of sap, the tree requires several incisions, or a single one in spiral form around its entire length; while others express the opinion, better founded, perhaps, that a single incision made in the lower part is sufficient, as the force of gravity causes all the sap to run down without much injury to the tree.

It is well to be careful, after all the sap is taken out, to heal the wounds made by the incisions, by covering them with wax, woollen stuffs, or clay.

CONCLUSION.

In my opinion, what precedes is sufficient to demonstrate incontestably the great future of rubber culture in Mexico, and the large profits it would yield after a few years to those who would devote themselves to that industry. *It may be affirmed, without any exaggeration, that neither cocoa, tea, coffee, sugar-cane, henequen, indigo, nor any* *other tropical product, would give the same profits as rubber, and the returns from each of these enterprises are, in reality, equal to those obtained from a rich mine.*

When that culture is propagated in Mexico, it will open up a source of inexhaustible wealth that will change the fate of the rubber-growing districts, which, from being poor and miserable as they now are, will become rich and opulent when that plant begins to produce. Anyone in a situation enabling him to make a rubber plantation of greater or less extent may undertake it at once with the full conviction that it is the safest and most lucrative industry. *While the coffee, cocoa, sugar-cane, or any other plantation, in favorable years and under good conditions, can give a return of one hundred per cent. on the capital invested in the year, not upon the capital expended in preparing the plantation, including the value of the land, one of rubber will give over one thousand per cent., not alone upon the cost of the extraction, but upon the first capital invested, including the value of the land.*

I shall consider my efforts amply rewarded, if the data contained in this paper shall in any way realize the object I had in view in writing it, and which is to create among our agriculturists the desire to plant fields of rubber-trees in suitable localities. By so doing they will be assured of a bright future, and contribute on a large scale to increase the wealth of the country, to promote the welfare and prosperity of places where to-day poverty reigns, and where it can scarcely be said that civilization has penetrated.

I shall be very glad if persons of knowledge and experience in this important branch of public wealth fix their attention upon this subject, and, by their writings, contribute to the great object that I have simply indicated, correct the errors contained in this paper, and supply whatever is lacking to complete it.

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